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LECTURES

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# PHARMACY

PRESENTING A SERIES OF TWELVE LECTURES

IN ACCORDANCE WITH THE SEVENTH DECENTNIAL REVISION

OF THE

PHARMACOPŒIA OF THE U. S. A.,

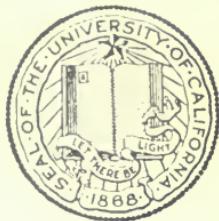
1890.

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# Pharmacy.

The generic term Pharmacy includes the several *sciences* which contribute to the knowledge of drugs and medicines, and the various *arts* requisite to the practical application of such sciences in the preparation of medicine. Pharmacy, therefore, being a combination of science and art, may be divided into two comprehensive departments, *theoretical* and *practical*.

## THEORETICAL PHARMACY.

*Theoretical Pharmacy* embraces nearly all the natural sciences, for the reason that all the different kingdoms of nature—animal, vegetable, and mineral—contribute substances used in medicine, and hence the three general sciences, zoology, botany, and mineralogy.

All matter belongs to one of these three great divisions, and is accordingly classified and described as to its physical characteristics, or sensible properties, in the corresponding sciences.

When, however, we inquire into the laws which govern the character or properties of substances, as related simply to the changes in such bodies, or to the origin or causes of such changes, when these do not affect the identity or sensible properties or constitution of the matter, such science is termed *physics* (from *physis* (lat.), nature).

When these changes are such as to involve the loss or transformation of one substance into another or into different substances, it is termed *chemistry* (from *chymenia* (arab.), juice, mixture).

Examples of these two forces, respectively, may be illustrated by familiar phenomena: A piece of lime broken into fragments by force, the movement of a small piece of iron toward a magnet, or that of a stone back to the earth from which it had been thrown, the floating of a piece of wood on water, and a thousand and one similar incidents of constant occurrence—all these are dependent upon or explained by physical laws, the science of which is termed *physics*.

On the other hand, when these same substances are treated so as to change their composition, as, for example, when a piece of well-burnt lime, dampened with water, becomes heated, is transformed into calcium hydrate (slakes), and falls into powder, which, absorbing carbonic acid from the atmosphere, is converted into calcium carbonate or chalk; or when a piece of iron exposed to dampness rusts, forming oxide of iron; or when sugar, through fermentation, is decomposed into alcohol and carbonic acid; in short, whenever the change affects not only the physical characteristics, but also the elementary composition of a substance, it is called a chemical change, and the science contributing to a knowledge thereof *chemistry*.

The sciences named, we may say, therefore, constitute *theoretical pharmacy*; that is, they are the basis of pharmaceutical science. From this, however, it must not be presumed that a thorough knowledge of all is essential to a knowledge of pharmacy; while such knowledge would be very desirable, an intimate knowledge of each would be entirely too comprehensive, in fact, quite impossible to attain by any one engaged in active business. It is nevertheless desirable that, in pursuing studies in pharmacy, a limited knowledge of these should be had in a general sense; zoology and physical laws will not come under our province, except as they may be necessary to elucidate a special subject embraced in these lectures.

The fundamental principles of matter should above all be mastered to enable the student to understand more readily and thoroughly the various operations and processes involved in pharmacy, and it is recommended that, conjointly with the first lectures, the first chapters in an elementary chemistry or in some work on physics be carefully reviewed.

The vegetable kingdom furnishes the largest number of substances used in medicine, hence its importance in the study of pharmacy.

*Botany* (from *Botane*, plants), which will be treated in the Second Term, is the science in which all plant or vegetable life and its parts are classified and described.

*Mineralogy* (from *Minera*, earth, and *logos*, science) is the science of minerals, and in connection with physics, has, we may say, established that science, which perhaps is the most important of all in the study of pharmacy, namely, chemistry. While this subject is reserved for the Second Term, such reference will be made thereto during the First Term as may be deemed essential.

*Materia Medica* (medicinal matter). This term is applied to all material or substances used in medicine, frequently only to such derived from the vegetable and animal kingdoms, when it is termed "organic." The term is also often applied to the general knowledge and uses of medicines.

*Pharmacology* (from *Pharmakon*, drug, and *logos*, science) is the science of the uses and properties of remedies; hence, in one sense, the science of medicine.

*Pharmacognosy* (from *Pharmakon*, drug, and *cogno*, to know) is the science of crude drugs, organic or inorganic, their identification and valuation. The term is seldom used.

*Pharmaceutical* is a term applied to any science or attribute having

relation to pharmacy; *e. g.*, pharmaceutical botany, phar. chemistry, phar. preparations, phar. literature, etc.

The terms *pharmacal* as applied to the attributes of pharmacy and *pharmaceutical* as applied to drugs or their preparations, mark a distinction very desirable, as in the case of *medical* and medicinal. The term pharmacal has not yet, however, been generally accepted by standard authorities.

#### THE PRACTICE OF PHARMACY.

The Practice of Pharmacy embraces the selection, identification, preparation, preservation, and dispensing of medicines, and may be defined as the practical application of the theoretical sciences, or the *art* of pharmacy.

*Pharmacy*, derived from the Greek *pharmakon*, which means a drug, is the most popular term for the place in which pharmacy is practiced. The derivation of *drug* is from the Saxon, the English *dry* referring to organic substances required to be dried before being used in medicine. Literally *drugs*, therefore, means only substances of animal or vegetable origin, and a *drug store*, a place where they are stored and sold. The *Apotheke* is also of Greek origin and has the same meaning, being converted into *Botica* in Spanish. *L'Officin* is the most common French term. From these the various titles of those practicing the art have been derived: *Pharmacist*, *Druggist*, and *Apothecary*.

The subjects embraced in the first three lectures, *viz.*, Metrology, Heat, and Solution, are, it may be said, the ground-work of pharmacy. Upon these rest all the operations involved in pharmaceutical practice, and a thorough understanding of these becomes, therefore, absolutely essential. While one whole lecture has been devoted to each of these subjects, the student is recommended to still further pursue their study in some elementary work on physics or chemistry.

*selection of medicine in  
some dynamics and principles  
of the art*

## Pharmacy Laws.

Though the pharmacy acts in force in the various states differ more or less in structure and detail, they all have a common purpose, *viz.*, to confine the practice of pharmacy to such persons only as may appear qualified to perform their duties intelligently, and with safety to the public.

#### PHARMACY LAWS NOT "CLASS LEGISLATION."

The impression is prevalent that pharmacy laws are designed especially for the benefit of persons engaged in the drug business. No law of the kind was ever in justice enacted upon this theory. Law-making bodies have no right to legislate directly in the interest of any

special class or profession of men. Representing the people in general, they are bound to consult only the interests of the people, and it is this principle alone which should dictate the provisions of all pharmacy acts, and which should exclude any clause not required for the protection of the public. For druggists to ask legislation upon any other principle would be a species of mendicancy to which a legislature could not yield without self-stultification and a betrayal of its trust.

#### LEGISLATION PROTECTIVE OF THE PUBLIC.

That pharmacy laws are essential to the public health and safety admits of no denial. That incompetent persons should not be permitted to defeat the purpose of intelligent prescribing, and bring death and sorrow to anxious homes, is self-evident; that every precaution should be taken to insure the utmost skill, knowledge, experience, and conscientiousness in these questions so closely related to the dearest associations of earth, so vital to the preservation of homes, and to the happiness of the people, will be universally conceded. Disease too often conquers, despite the resistance of medical and pharmaceutical science; but who will say how many deaths, ascribed every day to disease, may not be due in fact to inexperience or ignorance in our pharmacies? Education at the dispensing desk is not less important than at the bed-side. One should faithfully supplement the other, and a sacred privilege of the former is to correct, when need be, any palpable error of the physician, committed amid the confusing scenes frequently occurring in the sick-room.

But, we are told, if special laws are necessary in the case of drug stores, why not in the case of grocery stores and other sources of food supplies? Is not food as important as medicine, and is not the public able to care for itself, and to avoid unreliable places? We answer that, as regards the ability of the public to discriminate, there is little or no analogy between drug and food stores. A little experience by a person of average intelligence will usually assure a tolerably accurate judgment of qualities of food, and if an error be made, it is very rarely of immediate and critical consequence. But even the more intelligent drug-store patron, on the other hand, may be presumed to know absolutely nothing respecting the nature, qualities, doses, or compounding of drugs, and, if an error be made, it is too often disastrous if not fatal in its results. While a good law against adulterations is, therefore, usually sufficient to protect the public against unwholesome food, nothing short of a law which shall reach the *dealers in drugs*, which shall exclude the incompetent, and assure all possible skill and trustworthiness in medical dispensing, can be regarded as adequate.

#### IMPORTANCE OF LEGISLATION TO PHARMACY.

Because pharmacy laws are not framed in the interests of pharmacists, it must not be presumed, however, that they do not benefit the

profession. The protection, though incidental to that designed to be given to the public, is none the less valuable and important. The discrimination against incompetency and quackery demanded by the public welfare is inevitably associated with discrimination in favor of the educated, the experienced, and competent.

It is for this reason that every reputable pharmacist has a special personal interest in the enactment and maintenance of pharmacy laws. While they accord to his profession a legal status, honor it with distinctive recognition among the learned sciences, purify it by rejecting elements which otherwise would tend to degrade and disgrace, elevate it to a rank of dignity, strengthen it with possibilities for the more rapid development of its literature, for the growth of its educational institutions, and for substantial advancement in efficiency—while accomplishing these great results, these laws also confer direct business advantages by restricting the number of druggists, reducing competition, and thus, by dividing the trade into fewer parts, assure to each more nearly adequate remuneration.

We repeat that, while the public has a general interest in pharmacy laws in times of sickness, the educated pharmacist has a special professional and mercantile interest in their maintenance at all times.

#### THE STRUCTURE OF PHARMACY LAWS.

The precise character of an ideal pharmacy law we shall not attempt to describe. This species of legislation is still in its infancy, and years of experience will be required to develop it, and to adjust it to American institutions. Certain fundamental provisions are, however, indispensable to a just and efficient law:

(1) Its scope should include, for reasons previously stated, only such departments of the pharmacy as require the exercise of special professional qualifications. For this reason, "patent medicines," and certain "domestic remedies," the vending of which requires no special scientific knowledge, may properly be subject to less stringent regulations.

In the event of legislation requiring that all proprietary or patent medicines be sold under certain restrictions, to protect the public against the indiscriminate use of substances creating noxious habits, or of otherwise dangerous properties, such protection could only be afforded by confining their sale to persons by education and training fitted to understand the character and properties of medicine. Next to the physician the pharmacist is the best judge of the use as well as the abuse of medicines, and by virtue of his position as dispenser he should, therefore, be accorded the sole responsibility of selling all medicines, knowledge of the contents being invariably assured.

(2) All druggists in business when a new law has taken effect have, for constitutional and prudential reasons, been permitted to continue in practice, and all clerks of sufficient experience have been permitted to continue in their duties.

(3) The proper administration of the law requires a Board of Pharmacy composed of experienced and thoroughly educated pharmacists.

(4) In many states, all persons desiring to engage in the practice of pharmacy are required to pass a satisfactory examination before the Board. In other states, diplomas of colleges are accepted for registration in lieu of examination.

The recognition of diplomas has been a hazardous experiment in some states where physicians have insisted on the recognition also of medical diplomas. It also presents difficulties in that there are no means of discriminating against diplomas from colleges or schools of no standing, and such who do not require experience in practical pharmacy. Until the instruction in the colleges is more uniform, it is the safest plan to require all candidates for registration to be examined by the Board.

(5) In the absence of a legislative appropriation, it is clearly good policy for the persons most interested in maintaining the law—the druggists—to provide the requisite revenue. The payment of a small fee annually by all pharmacists registered appears to be the most feasible method for the purpose, and insures correct registration.

(6) The penalties for violation should be sufficiently severe to insure respect, and sufficiently certain to insure prompt conviction. To insure conviction the Board of Pharmacy should be charged with the duty of causing prosecutions.

The constitutionality of the principle embodied in pharmaceutical legislation has been affirmed by several Supreme Courts, and prosecutions under the various state laws, in the absence of verbal defects, have quite invariably been successful. Supported by the people, the courts and the profession, their foundations are deep, firm, and, we may assume, permanent.

State pharmacy laws are now in force in all the states and territories of the Union except in a few states, Maryland (except Baltimore), Nevada, the Indian Territory and Arizona. Texas has a separate Board for each judicial district.

Several State Boards recognize the certificates of other State Boards. But in most states pharmacists registered in another state have no advantages over an unregistered person. While this frequently causes great inconvenience and even hardship to pharmacists desiring to change their location from one state to another, it seems unavoidable under existing conditions. The New York Board, for instance, cannot afford to abdicate its authority in that state by accepting certificates from Illinois or Michigan, which would practically give to the latter co-equal authority without possibly maintaining a co-equal

standard of examinations. The only manner in which reciprocity can be properly brought about is, first, by making all laws practically uniform in their conditions for registration; or, second, that all Boards agree upon a common standard for examinations. The first requisite appears to be a remote possibility, and the second has been attempted, but without success.

#### BOARD OF PHARMACY EXAMINATIONS.

It may be assumed that the standards adopted for examinations by State Boards of Pharmacy are designed with a view of determining whether or not the applicant be sufficiently competent to prepare and dispense drugs and medicines, and therefore qualified to conduct a pharmacy. As this can only be determined by an examination chiefly theoretical in character, it is obvious that practical experience in pharmacy alone, unless associated with information obtained by a systematic study, is not sufficient to insure success. While such examinations may be largely theoretical, they are nevertheless calculated to draw out information which is also practical; in fact, theory and practice are so interwoven and interdependent in pharmacy that they are necessarily inseparable.

Although the various State Boards of Pharmacy have individual standards of examinations, they all have a common basis in the different branches, as follows:

*Pharmacy.*—Pharmaceutical preparations of the U. S. P.; their component parts or ingredients, mode of preparation, strength and doses; weights and measures; dispensing of prescriptions.

*Chemistry.*—The chemical compounds and preparations of the U. S. P.; their physical and chemical properties; specific gravities; percentages of anhydrous acid and degrees of saturation; preparation of and tests for the more simple compounds, such as calomel; enumeration and description, and sometimes distinction, of compounds from a certain metal, such as the chlorides of mercury; incompatibles; poisons; preparation of oxygen, chlorine, etc., involving elementary chemistry.

*Materia Medica.*—Latin titles for vegetable drugs, and name of natural order, with a brief description of their botanical and physical characteristics; name of active principles, their properties and doses.

*Identification of Specimens:*

Of crude drugs, such as cinchona, columbo, senna, taraxacum, etc.

Of chemicals, alum, borax, saltpeter; sulphates of iron, copper, zinc, etc.

Of pharmaceutical preparations, tinctures of opium and opium camph., syrups, glycerin, etc.

A verbal, and in some states a practical, examination is added to the regular written examination, in order that the Board may most thoroughly satisfy itself as to the competency of the applicant.

## The Pharmacopœia.

The great confusion concerning the identity of medicinal substances and the variation in the strengths of their preparations caused the compilation of certain medical works at a comparatively early period for the promotion of a scientific standard of quality, process, and composition. These works were issued under medico-legal authority, and called PHARMACOPŒIAS, from *Pharmakon* (drug), and *poiein* (to make). The first book of this character was the Pharmacopœia of Valerius Cordus, published at Nuremberg, Germany, in 1546. Previous to this time many individual publications had appeared named DISPENSATORIES. The Dispensatories thereafter became commentaries on the Pharmacopœia, including, as do the American Dispensatories, all information pertaining to the pharmacy as well as the action and uses of medicines.

It must therefore be remembered that, while a Pharmacopœia is a standard and legal authority, the Dispensatories are private publications, only to be used as reference, and not intended to take the place of the former.

The first Pharmacopœia for the United States of America was published in 1820, in Boston, in both the English and Latin languages, according to a draft endorsed by a convention of representatives from the medical colleges and societies held in Washington, D. C., that year. Revised editions appeared successively in 1830 and 1840, when much assistance was rendered by the Boston, New York, and Philadelphia colleges of pharmacy. In this revision the Latin version was dropped, and the process of displacement or percolation introduced for the first time. Succeeding revisions have appeared since regularly every ten years, the representatives of the colleges of pharmacy assuming practically charge of the sixth (1880) and seventh (1890) decennial revisions; the representatives of medical associations and colleges merely confirming the work done by the pharmacists.

There are about twenty different pharmacopœias, that of the United States occupying undoubtedly, in point of scientific arrangement, completeness and accuracy, a place second to none.

The Pharmacopœia may be defined as an authoritative work which: (1) establishes *standards* for the identification, quality, purity, and strength, and (2) gives *directions* for the preparation, purification, and preservation of drugs and medicines.

The United States Pharmacopœia, 1890, became *official* January 1, 1894, which means that it is at present, and until again revised will be, the *only* recognized standard for the *identification, strength, and purity* of drugs and medicines in the United States. The requirements of the Pharmacopœia are therefore said to be *official* as to strengths, tests, etc.; the method of preparation is likewise termed the *official* process.

The terms *official* and *officinal* have been employed rather indiscriminately, but in the U. S. P., 1890, the latter term, *officinal*, has been dropped.

#### THE U. S. PHARMACOPÆIA OF 1890.

The principal changes of the present Pharmacopœia (1890) from the preceding revision (1880), in which the general features of a pharmacopœia are also represented, are the following:

##### THE NOMENCLATURE.

The Nomenclature (from *nomen*, name, and *callare*, to call, is alphabetic throughout, and embraces the following distinctions as illustrated in:

Magnesii Sulphas,      Official Latin Title.

Magnesium Sulphate,    "      English Title.

Epsom Salts,      English name.

Bitter Salts,      Common name, or Synonym.

In the nomenclature may also be regarded the descriptions of the articles according to their derivation:

*Chemical*.—The Chemical Formula according to the new notation and the Molecular Weight.

The English titles and names of chemicals being reversed, that is. Magnesium Sulphate instead of Sulphate of Magnesium; Ferrous Sulphate instead of Sulphate of Iron, etc.

*Botanical*.—The Latin Title to be the *genus* name of the plant; exceptions in *Coca* for *Erythroxylon* and *Cusso* for the former *Brayera*.

The *part* of the plant official is not incorporated in the title, except where more than one part of the same plant may be employed, as in *Belladonna Folia* and *Radix*. The botanical *name* of the plant is always accompanied by the name of the author (L—Linne) and the natural order.

##### WEIGHTS AND MEASURES.

The percentage parts-by-weight system, was introduced in the U. S. Ph., 1880, as it was thought preferable to the Metric system.

The objection to weighing liquids were too great to be overcome during the ten years' life of the U. S. Ph., '80, and the system entailed so great variation in liquid preparations, on account of the difference in specific gravities, that it did not become popular. It was an advantage, however, in preparing the way for the *Metric System*, which was introduced throughout the U. S. Ph., '90, except in a few instances where the advantage of the percentage-by-weight system was obvious.

#### THE CHANGES IN STRENGTH.

These have been effected in many liquid preparations by changing the Formulas from parts-by-weight to *weight* and *volume*. These changes are not, however, considerable, except in the general Formulas for Decoctions and Infusions, in both of which the drug strength has been reduced one-half; that is from 10 to 5 per cent. Some changes have also been made in the strengths of the liquid Acids and Dilute Alcohol.

#### STRENGTH FIXED BY ASSAY.

The alkaloid percentage requirements of the U. S. Ph., '80, for Cinchona and Opium, the U. S. Ph., '90 has extended to the most important preparations of the latter and also to those of Nux Vomica.

The animal ferments, Pepsin and Pancreatin, are also required to have a certain digestive strength.

The strength of Spirit Nitrous Ether is determined by *gasometric estimation*, and certain organic bodies are tested by *the determination of their optical rotation*.

#### NEW SUBSTANCES ADDED.

Some thirty Organic substances have been added, including many new remedies, such as Acetanilide, Resorcin, Salol, etc., while none have been dismissed. Of Crude drugs 10 have been added and 23 rejected.

Only a few Inorganic substances have been added as against an equal number dropped; while 50 Pharmaceutical preparations, including the 11 Abstracts, have been replaced by 36 new preparations, in which there are 10 Fluid Extracts and 4 each of Glycerites and Waters.

Altogether there are 994 articles included in the U. S. Ph., 1890, two less than in its predecessor.

## Metrology.

*Metrology* (from *Metron*, Gr., measure, and *logos*, science,) treats of the gravitating force of a body called *weight*; its extension, bulk or volume, called *measure*, and the relation of these to each other called *specific gravity*.

The *weight of a substance* is the downward pressure which the earth's attraction causes it to exert.

All bodies attract each other with a force which is directly in proportion to their mass, or the quantity of matter which they contain, and inversely proportional to the squares of their distances apart. This attraction is called *gravitation*.

Since weight is due to gravity, and gravity is in proportion to the quantity of matter contained in the attracting bodies, weight, other things being equal, will vary as the quantity of matter varies, and a body with twice the quantity of matter or twice the mass of another body, will weigh twice as much. We may therefore estimate the quantity of matter a body contains by *weighing* it.

But it must be distinctly borne in mind that gravity and weight are not the same thing. Weight may vary while the mass remains unchanged. The weight of a substance at the sea-level is not quite identical with that of the same substance at a mountain-top, for the reason that in the latter instance, being farther from the earth's center, the attraction is less; and for the same reason it is not so great at the equator as at the poles. It must also be borne in mind that in weighing a body in the air, the air has a buoyant effect and diminishes the weight of the body in the ratio of the weight of the air which it displaces. Of two bodies, therefore, containing precisely the same quantity of matter, but the one a large body, say like a piece of cork, and the other a small one, as a piece of lead, the lead will weigh the most in the air, although a mere trifle.

In ordinary weighing, where extreme accuracy is not required, of course no corrections need be made for latitude or distance from the earth's surface, but it is not uncommonly the case, particularly in chemical research and in weighing very light bodies, that these and the buoyant effect of the atmosphere must be taken into account.

For this reason the barometric pressure is often referred to in connection with the weight of substances, and the standard unit weighed in the absence of air pressure, namely, *in vacuo*.

Since, also, bodies expand by heat and contract by cold, the *temperature* must frequently be taken into account in weighing a body.

The temperature most commonly employed being  $15^{\circ}\text{C}$ . or  $59^{\circ}\text{F}$ . For scientific work the temperature is referred to  $4^{\circ}\text{C}$ ., the maximum density point of water.

#### THE BALANCE.

*Weighing* is accomplished by arbitrarily assuming a unit of weight, and then comparing the pressure of the body to be weighed with that exerted by the unit, by means of a balance.

The principle upon which the scale or balance is constructed is so simple and well known as to need scarcely any description. With the use of fine instruments, however, such as the prescription-balance, it is well to bear in mind that they should be treated with care. The more sensitive a balance, the more delicate is the construction, especially of the knife-edges upon which the beam rests, and that of the knife-edges of the extremity of the beam from which are suspended, by means of wire, the pans.

To insure accuracy in a balance, the point upon which the beam rests must be just *above* the center of gravity of the balance; the point of suspension of the pans must be *in a line* absolutely with the fulcrum; the beam must be of sufficient strength to support the weight without bending, and the arms of the beam must be of *equal* length.

A fine balance should always be inclosed in a glass case to keep it free from dust, and more especially to protect it from the corrosive effect of acid fumes, etc., which attack the steel-knife edges, and thus impair their sensitiveness and prevent accuracy in weighing.

The *Box-Dispensing Scale* is constructed upon the compound-lever principle, and is more convenient to use, easier to keep clean, but more liable to get out of order. It answers admirably for dispensing and prescription work, but is not sufficiently delicate for analytic purposes.

The *pans* of a balance should always be allowed to rest, to prevent oscillating when not in use, which may be best accomplished, in the absence of a permanent fixture accompanying the balance for that purpose, by placing one pan on top of the other until wanted. Care should also be taken that corrosive articles, such as iodine, mercuric chloride (corr. sublimate), and potassium and sodium bromides and iodides, etc., when dispensed, should be weighed in glass pans, which usually accompany the balance, or in watch glasses of equal weight.

In *weighing* adhesive substances, such as extracts, etc., small pieces of white cardboard of equal weight should be used. The extract required is, my means of a spatula, placed upon one piece, while the

other serves as a counterpoise or tare upon the opposite pan. A fine balance will remain in good condition much longer when it is reserved for weighing smaller quantities only, say below one dram. It will be found very convenient to have a coarser scale on the dispensing counter for weighing quantities above one dram and for ointments, etc. A small box or vial of shot, or some similar substance, should always be near at hand, to be used in taking the tare of bottles or containers, when it is necessary to weigh fluids, or whenever a receptacle is used in weighing.

The *weights* used in weighing are usually metal, the downward pressure of which is compared and marked according to some fixed standard.

They are commonly made of iron and brass. For delicate purposes, such as weighing with prescription and analytical balances, weights are made of aluminum wire for prescription scales and of German silver and platinum for analytical scales. These weights should be preserved in a small box or drawer, protected from dust and from the corrosive action of chemicals, which would impair their accuracy. They must be kept bright and clean to be reliable, and for this reason should be handled with a pair of light forceps instead of with the fingers. Weights should be secured from reliable sources, or tested as to their accuracy.

The standard of the avoirdupois pound may be obtained (aside from the official method elsewhere described) as follows: A bar of iron, one English yard long, planed exactly one inch square, weighs about 10 pounds; one-tenth of this will weigh one av. pound.

*Liquids*, as a rule, are measured while solids are weighed; nevertheless, it is frequently required that a certain liquid be weighed. While the difference between weighing and measuring some liquids is not very great, yet with others it is considerable, and, without discrimination, it may frequently produce entirely different results. [See Specific Gravity.]

# Weights and Measures.

## WEIGHTS—AMERICAN AND ENGLISH.

The systems of weight in use in the United States are Avoirdupois and Apothecaries' or Troy.

*Apothecaries' Weight* was adopted as the official standard in all the editions of the U. S. Pharmacopœia previous to that of 1880. Although not officially sanctioned, Apothecaries' weight still remains in use in the prescribing of medicines, owing to the ease with which it can be subdivided into simple fractions. One troy ounce, equal to 480 grains, is easily divided by any even number—2, 4, 8, etc. This quality is of great practical value to pharmacists and physicians. For the latter, it simplifies prescribing because of its easy division; the quantity of a remedy required for administration may be computed with the measure of the solvent very quickly in simple fractions.

The fluid measure used in pharmacy can always be reduced to drams—the equivalent of a teaspoonful. This being the measure ordinarily used in administering medicines, the quantity in a dose is readily ascertained. When, for example, one grain of morphine sulphate in one fluid ounce of water is prescribed, with directions "one teaspoonful at a dose," it is readily computed that the quantity of morphine in each dose must be one-eighth of a grain, since one fluid ounce contains eight fluid drams or teaspoonfuls. Should eight grains of morphine sulphate in one ounce of water be prescribed with the same directions as above, the pharmacist at once computes the quantity of morphine in each dose to be one grain, and from this decides whether or not the mixture should be dispensed.

The following is a summary of Apothecaries' weight, showing the number of grains in each denomination:

Scruple.	Dram.	Ounce.	Pound.
20	60	480	5760

The Troy ounce, though containing the same number of grains as the Apothecaries', is divided into 20 pennyweights instead of drams and scruples. Its use in pharmacy is practically obsolete.

*Avoirdupois Weight* is the commercial standard of the United States and Great Britain. One av. pound is equal to 7,000 grains, being 1,240 grains more than one troy pound. This difference is chiefly due to the fact that the av. pound contains 16 ounces, while

the troy pound contains but 12 ounces. Why should not the difference, then, in the number of grains in the two different pounds, have the same relation as 16 to 12? If one av. pound is equal to 7,000 grains, one troy pound should equal 5,250 grains, and not 5,760 grains. Here is an unfortunate relation existing between these two kinds of weights; while the troy ounce is equal to 480 grains, one av. ounce equals only 437½ grains, which explains the difference in the number of grains to the pound.

The odd number of grains in the avoirdupois ounce, as compared with the round, easily divided, number of grains of the apothecaries' ounce, is due to the fact, that in the Apothecaries' the *unit* is the ounce, and from this the pound was formed. In the Avoirdupois the pound is the *unit*, which divided by 16 gives an ounce containing only 437½ grs., as against 480 grs. in the Apothecaries' ounce.

The following table gives a summary of avoirdupois and apothecaries' weight with their respective symbols and customary abbreviations:

480 grs. =  $\frac{5}{3}$  i; then  $\frac{5}{3} \times 12 = 5,760$  grains, or 1 troy lb.

437½ grs. = 1 oz.; then 16 ozs. = 7,000 grains, or 1 lb. av.

The number of *grains* in the various denominations are as follows:

	Dram.	Ounce.	Pound
Avoirdupois, . . . . .		437½	7,000
Apothecaries' or Troy, . . . . .	60	480	5,760
Difference in favor of apothecaries', . . . . .		42½	
Difference in favor of avoirdupois, . . . . .			1,240

#### MEASURES OF CAPACITY.

The measures of capacity in use in the United States are "Wine" and Metric measures.

The measures of bulk or volume are primarily derived from the *linear* system (measure of length) and the system of weights, in turn, from that of volume.

One cubic inch of distilled water, at its maximum density, a temperature of 4°C. *in vacuo*, weighs 252.892 grains, and 231 cubic inches is a measure equivalent to the U. S. Gallon.

The *Gallon* is divided into eight pints; one *pint* into 16 fluid ounces; one *fluid ounce* into 8 fluid drams, and 1 fluid *dram* into 60 *minims*.

The measure of volume may therefore always be compared with the weight of water as above, the standard for comparison, thus:

1 cubic inch = 252.892;  $252.892 \times 231 = 58,418$  grs. = 1 Gallon

$58,418 \div 8 = 7,302$  grains = 1 Pint.

$7,302 \div 16 = 456.2$  grains = 1 fl. Ounce.

$456.2 \div 8 = 56.2$  grains = 1 Minim.

These are the exact weights of the respective measures at the official temperature, but the comparison is frequently made at a higher temperature. Water reaches its maximum density at 4°C., when one pint weighs 7,302 grains, and this is the standard adopted by the Office of Standard Weights and Measures of the United States. In these lectures the round number, 7,300 grains, equivalent to one pint, has been adopted as sufficiently accurate in comparing weight with volume.

*Measure*, in pharmacy, is a term usually applied to a certain standard for estimating the dimensions of liquids, or the capacity of vessels used as containers. When of the larger dimensions, measures are made of copper or tinned iron—preferably the latter, because it is not so easily dented as copper.

In the dispensing of medicines, graduated glass measures are used; they should always be tested with measures of known accuracy, or by weighing their capacity of pure water, which should be a certain weight, if the measure be correct. [For testing any measure of capacity, refer to standard for weights.]

A *drop* is not a minim, and the measurement of liquids by drops does not give uniform and accurate results. The size of drops varies greatly with different liquids; also with the same liquids, according to the conditions governing the process of dropping. Among these conditions are, chiefly:

- (1) The quantity of the liquid contained in the vessel.
- (2) The size and shape of the lip of the vessel.
- (3) The rapidity of the dropping.
- (4) The temperature of the liquid.

The size of a drop cannot be estimated by the specific gravity of the liquid, since some substances of great density (*e. g.*, chloroform) yield smaller drops (300 to 1 dram) than those obtained from liquids comparatively light, as, for instance, ether.

The size of drops of different liquids, estimated by the number to one fluid dram, may be generalized as follows:

	Drops in one fluid dram.
Watery solutions, including dilute acids, . . . . .	50 to 60
Alcohol and strongly alcoholic liquids, spirits, and tinctures, . . . . .	120 to 140
Alcohol dilute., including tinctures from the same, . . . . .	100 to 120
Ether and ethereal prep., including spirit ether. nit.; sp. ether. comp., . . . . .	120 to 150
Oils, ethereal, . . . . .	90 to 110
Oils, fixed; glycerin, . . . . .	65 to 80
Chloroform, . . . . .	200 to 300

By means of the pipette drops of fairly uniform size may be obtained, and these should be supplied for dropping very active preparations, such as Fowlers' Solution, etc.

## The Metric System.

The Metric System of weights and measures was originally introduced in France at the close of the eighteenth century; hence it is frequently termed the French system. Owing to its decimal parts it is often also called the *decimal* system. This system has gradually displaced all the various systems of weights and measures throughout the continent of Europe, being the only legally recognized system in all countries, except Russia, Great Britain, her colonies, and the United States of America.

Because of its simplicity in construction, regularity and convenience in exact calculations, it has become the only system for scientific work, and is no doubt destined to soon displace the older systems in art and commerce throughout the civilized world. Through our system of decimal numbering: ones, tens, hundreds, thousands, etc., the monetary systems of all civilized nations except Great Britain have also become decimal and brought with them the metric system.

The functions of money and weights and measures are so closely related and interdependent that a *decimal* system of one practically demands a *decimal* system of the other.

The decimal system of money was one of the privileges accorded the people of the United States by early adoption, but while adopting this great improvement over the old English pound, shilling, and pence, the old English weights and measures, based on the penny-system, were unfortunately retained.

The U. S. Government in 1867 made the Metric system obligatory in the three branches of its medical service—the Army, Navy, and Marine Hospital—and also legally permissible throughout the Union, but all efforts to make it obligatory in the various states have so far proved futile.

There is some excuse for retaining the old systems in Great Britain, but none whatever in the United States with its decimal proportions of the *dollar*, the *dime*, and the *cent*, based upon the same principle as that of the Metric system.

Although employed in medicine to some extent since 1867, the first important attempt to introduce the Metric system was when the National Pharmacopœial Convention of 1880 instructed the committee to revise the sixth decennial revision of the U. S. Pharmacopœia in accordance with the Metric system. The committee, fearful of the radical change involved, disregarded the instructions, and compromised by employing the system of decimal *parts* or *proportions by weight*, instead.

The introduction of this system, whereby all liquids as well as solids were directed by *weight*, was a greater innovation and caused *more* variation and inconvenience than if the Metric system, in which the familiar method of weighing solids and measuring liquids has been retained, had been adopted throughout.

The variation was so great, in fact, that in the case of Fluid Extracts the Metric system had to be employed.

This attempt, however, made the introduction of the Metric system comparatively easy, and the next Pharmacopœial Convention unanimously decided that the seventh decennial revision of the U. S. Ph. (1890) be based upon the Metric system.

The objections to the adoption of the Metric system are: first, that being decimal it cannot be as easily divided on the binominal plan (halves, quarters, eighths, etc.,) as the older systems based on this principle of bisection. This weakness adheres also to the Dollar, which cannot be bisected further than the quarter, but an inconvenience more apparent than real and easily overcome.

The second objection made to it is, that the Orthography, the designation of the respective quantities, is not distinct, and is liable to create confusion and cause error. In this respect it shares the objection to all systems. Carelessness in designating quantities, or ignorance in their interpretation, is common in the older systems. Thorough familiarity with the principle, and accurate knowledge and care in its use, will demonstrate the *Metric system* as free from error as any of the older systems.

The *Metric System* is based upon the *meter*, which is the standard unit of linear measurement, being the ten-millionth part of one-fourth of the circumference of the Earth (the quadrant). It is, therefore, the one forty-millionth part of the entire circumference of the Earth taken around the Poles., measured by the *meridian* and not by the *equator*.

One *meter* is equal to 39.37 + inches.

The standard unit of liquid measure (termed the *Liter*) is the cube of one-tenth of the meter, or cubic decimeter, and one-thousandth part of it, or the cube of one-hundredth of the meter is one cubic centimeter.

The unit of weight is the weight of one cubic centimeter of pure Water in vacuo at its maximum density, termed *gramme* or *Gram*, equivalent to 15.432 grains.

The unit *Gram* (written with a period immediately following, thus, 1.) is divided or multiplied to express smaller or larger denominational quantities respectively, by simply moving the decimal point to the left or to the right.

To designate the quantities thus obtained, *Latin* prefixes are used to describe those less than one Gram, and *Greek* those larger than one Gram—the latter also being written with a Capital letter, as shown in the following, with their equivalents:

	Grains.
1. = 1 Gram, (abbrev. Gm.) . . . .	= 15.432
.1 = 1 decigram, (" deg., or dg.) . . .	= 1.543
.01 = 1 centigram, (" cntg., or cg.) . . .	= 0.154
.001 = 1 milligram, (" mg.) . . . .	<u>= 0.015</u>
	Grains.
1. = 1 Gram, (abbrev. Gm.) . . . .	= 15.432
10. = 1 Dekagram, (" Dg.) . . . .	= 154.32
100. = 1 Hectogram, (" Hg. or Hecto.)	= 1543.2
1000. = 1 Kilogram, (" Kg. or Kilo.)	= 15432.
	= 2 lbs. 3 oz. av., 120 grains.
10000. = 1 Myriagram, (" Mg.) . . . .	= 154320. grains.
	= 22 lbs. av. 320 grains.

## TABLE OF METRIC WEIGHTS.

1 milligram	= 0.001 gram.
10 milligrams	= 1 centigram = 0.01 gram.
100 " "	= 10 centigrams = 1 decigram = 0.1 gram.
1000 " "	= 100 " = 10 decigrams = 1 GRAM.
10 Grams	= 1 Dekagram.
100 "	= 10 Dekagrams = 1 Hectogram.
1000 "	= 100 " = 10 Hectograms = 1 Kilo.

## EQUIVALENTS.

Various methods have been proposed for adapting the metric weights to our apothecaries' weights used in prescription writing without entailing calculations in fractions. The method of taking 32 Grams as equivalent to one troy ounce, and 30 C. c., or fluid Grams, as equal to one fluid ounce, seems to be the least objectionable. These equivalents are shown in the following:

$$32 \text{ Gm.} = 1 \text{ oz.}; \quad 32 \div 8 = 4. \quad \text{Gm.} = 1 \text{ dram.}$$

$$30 \text{ C. c.} = 1 \text{ fl. oz.}; \quad 30 \div 8 = 3.75 \text{ C. c.} = 1 \text{ fl. dram.}$$

The exact metric equivalent of 1 grain is obtained by dividing the unit by the Gram equivalent in grains, thus:  $1 \div 15.432 = 0.0648$  gram (or  $6\frac{1}{2}$  centigram).

The metric equivalents of all the other denominations may be obtained by multiplying the grain equivalent by the number of grains in one dram; the number of drams in a troy ounce, etc. The following exact Gram equivalents are thus obtained:

1 grain.	1 dram.	1 ounce av.	1 ounce troy.	1 lb. troy.	1 lb. av.
0.0648	3.888	28.349	31.103	373.250	453.592

To convert avoirdupois or troy into metric weights, the equivalent of the Gram in grains—15.432—should be remembered, as it serves the purpose of a basis for obtaining the equivalent of all the higher denominations.

It will be observed that this number is composed of the first five numerals in reversed order, except the figure 1. In round numbers the Gram is said to equal 15 grains, the fraction being dropped, which, multiplied by 4, gives 4 Grams, equal to 60 grains or 1 dram; and these multiplied by 8—the number of drams in one ounce—give 32 Grams, equal to one troy ounce.

To convert metric weights into avoirdupois or troy, the easiest plan is to multiply the quantity in Grains by 15, securing the weight in grains. This is then readily brought back to the larger denominations by dividing it with the number of grains to the dram, ounce or pound. For example:

$$1452.5 \text{ (Grams)} \times 15 = 21,787.5 \text{ grains.}$$

$$21,787.5 \div 7000 = 3 \text{ lbs. av., 1 oz. av., 350 grains.}$$

With a small number, as, for example, 24 Grams, this calculation may readily be made mentally by adding one-half of the number to the original and then taking it ten-fold, thus; 24 Grams:

$$24 + 12 = 36; \quad 36 \times 10 = 360 \text{ grains.}$$

The *Liter* is equivalent to 34 fl. ounces, half a Liter approximating one Pint, sometimes called a *metric pint* (17 fl. ozs.). The division or multiples of the Liter are not used, all fractions of the Liter being expressed in *Cubic centimeters* (C.C.).

The equivalent of the *Meter* is nearly 40 inches, from which the divisions may easily be rendered as follows:

1 decimeter, 4 in.; 1 Centimeter, Cm., 0.4 in.; 1 Millimeter, mm., 0.04 ( $\frac{1}{25}$ ) inch.

For further comparison of the different systems of weights, refer to "Preliminary Notes," page xlvi, and also Table of Equivalents in the U. S. Ph., 1890.

The advantages of the Metric system consist in:

1. Simplicity of construction, abolishing complex tables.
2. Uniformity, through its adoption in all scientific work.
3. Permanence and Stability of its standard unit derived from the Earth itself.
4. Facility of its multiplication and division by decimal points.
5. Commensurability of all its units and denominations in *weight, volume, linear measures* and our system of *money*.

## Specific Gravity.

It is well known that some liquids are lighter than water, *i. e.*, ether, alcohol, etc.; others again are heavier, *i. e.* glycerin, sulphuric acid, etc. The weight of a certain measure of any of these liquids divided by the weight of the same measure of distilled water is termed the *specific gravity* of that liquid.

Thus, if a bottle hold exactly 1,000 grains of water, but of alcohol only 820 grains, the weight of the latter is as 820 is to 1,000. Water being the *standard for comparison*, it is stated to be 1., and if the weight of the liquid is lighter than water, as in the above instance, it becomes a decimal of 1., or, in this example, 0.820. If the bottle is filled with a liquid heavier than water, as, for example, glycerin, of which it would hold 1,250 grains, the weight is compared similarly, viz., 1,000 is to 1,250 as 1. is to 1.25, the specific gravity of glycerin.

The specific gravity (or specific weight) therefore of a substance is its *weight* in comparison with the *weight* of a similar *bulk* or volume of some other substance, or may be defined as the relative weights of *equal* bulks of *different* bodies, compared with some definite standard at the same temperature.

The standard for comparing the specific gravity of liquids and solids is distilled water at a certain temperature, viz., 15°C. (59°F.), U. S. Ph.

For gases the standard is Hydrogen at 1.

*Example.*—A certain quantity of glycerin equal in volume to 100 grains of water weighs 125 grains; if we divide the weight of the glycerin by the weight of the water the quotient will be the specific gravity of the glycerin. Thus: 125 divided by 100=1.25 specific gravity.

### IMPORTANCE OF TEMPERATURE.

Since all bodies expand or contract with changes of temperature, it is essential in comparing this difference in weight that the temperature of the substance be the same as that of the standard for comparison, water, viz., 15°C. (59°F.), except in the case of Alcohol, Wine, and alcoholic liquids generally, required by the U. S. Customs and Internal Revenue regulations to be taken at 60°F. (15.667°C.).

Constancy in temperature is especially to be observed in taking the specific gravity of liquids, since, with the exception of the metals, they are much better conductors of

heat than solids, and more readily expand and contract. Alcohol, ether, and benzin, for example, increase in bulk in proportion to the height of the temperature to which they are exposed, while they decrease in proportion to the degree of cold they are subjected to.

As a rule, the lighter the liquid compared with water, the more its bulk is changed by the temperature, *e. g.*, alcohol, ether, benzin. Conversely, the heavier the liquid as compared with water, when not below the freezing point, the less its bulk is changed by the temperature, *e. g.*, acids, glycerin, syrups.

With solids these rules are reversed. *Heavy* substances, such as metals, contract and expand, as illustrated in iron rails. *Light* solids are scarcely affected at all, such as glass, wood, coke, etc.

#### THE VALUE OF SPECIFIC GRAVITY.

The *importance* of Specific Gravity to pharmacy lies in the fact that through it the *identity*, and often the strength and purity of liquids, may be determined. Thus the percentage of *Absolute* acid in official Acids, such as, Hydrochloric, Sulphuric, etc.; the percentages of *salts* in the official Solutions, such as the Solution of Ferric Chloride and the amount of *water* present in Alcohol, Glycerin, etc., may be estimated from the respective specific gravities. For this reason the sp. gr. is always given *first* in defining the character of chemical liquids in the descriptive text of the U. S. Ph. While not always of itself sufficient to prove the identity, etc., it is always the first and essential step, which, in conjunction with the determination of the boiling or congealing points and other physical attributes, comprised in the term *character*, discloses the identity, purity or *otherwise* of substances.

The determination of the specific gravity of liquids, although an operation which should be practiced daily in the pharmacy, is nevertheless a process seldom attempted, and even the subject is one which is rarely understood thoroughly, even by those regarded as otherwise well qualified. This is chiefly owing to the fact that no practical demonstration is made at the time the subject is studied.

There exists in the mind of the beginner an exaggerated idea as to the implements or apparatus required for its performance, and as these usually are not at hand, he is disposed to content himself with learning the rules from the books, and, in consequence, soon forgets the principles involved.

This is entirely wrong. Practical demonstration at the time is the only means by which the principle can be thoroughly understood. While it is true that for great scientific accuracy delicately constructed instruments are required, sufficiently accurate results for all practical purposes may be obtained from the use of the ordinary apparatus in every pharmacy.

#### THE APPARATUS.

The necessary apparatus for taking the specific gravity of substances

is primarily a good balance, sensitive to at least 1 grain, and accurate weights; also a specific gravity bottle of known capacity by weight of water, the most convenient quantity being 50 or 100 Grams or 1,000 grains. Such bottles, termed *pycnometers*, are in the market, provided with a glass stopper, and accurately adjusted to hold, when completely filled, the exact weight indicated on them of distilled water at the standard temperature. An opening barely sufficient to admit a small needle permits the escape of air, which may have entered the bottle while being filled, as well as any superfluous liquid.

In the absence of a counterpoise, which usually accompanies the bottle, one is easily made from a piece of lead or other metal; or the tare of the bottle may be taken with ordinary weights. When first procured the bottle should be invariably tested as to its accuracy, by filling it with distilled water of the proper temperature, then wiping it dry, and weighing.

Glass-stoppered one-ounce iodine vials may sometimes be found which hold a convenient volume of water, and by making the incision lengthwise upon the stopper with a three-cornered file, an opening is produced which answers the same purpose as the orifice in the more expensive vials above described.

Bottles may also be selected from the ordinary prescription vials; for example a 100 or 120 cubic centimeter vial may be filled with distilled water at 15°C., and marked, with a file, on the neck at such point as may indicate a convenient even number of Grams of water. Such vial is not as accurate, however, as the glass-stoppered bottles, nor as convenient, since it involves more calculation.

Furnished with any of these objects, the veriest beginner in pharmacy can take the specific gravity of any liquid, the simplest knowledge of arithmetic being all that is required. It should be remembered that the thing sought is the *weight* of a quantity equal in *bulk* to a certain volume of water of known weight, or, as above expressed, the *relative weights* of *equal volumes*, or *bulks* of *different liquids* at the same temperature. A certain volume being decided upon as a standard for comparison, we express that by weight of water, and the weight of an equal bulk of any liquid is divided by this weight. When this standard for comparison can easily be converted into a multiple of ten, the division is effected by simply moving the decimal point to the left or right, as for example:

Glycerin. Water.

$$1,250 \div 1,000 = 1.250 \text{ sp. gr.}$$

Alcohol. Water.

$$820 \div 1,000 = 0.820 \text{ sp. gr.}$$

In proceeding to ascertain the specific gravity of a liquid, the bottle should first be rinsed with a little alcohol, which volatilizes more quickly than water, and leaves the bottle perfectly empty. After having ascertained the temperature of the liquid, which, as stated, should be 15°C (59°F.), the bottle is filled nearly to the top of the neck, the stopper is inserted and the superfluous liquid displaced by it completely removed from the bottle, which is then wiped perfectly clean and dry. The filled bottle is then weighed, after being balanced with the counterpoise. If the weight of the liquid is 1,250 grains, the specific weight is 1.25 ( $1,250 \div 1,000$ ). The weight of the water, whatever the quantity, is always taken at 1, and the weight of the liquid, whose sp. gr. is sought, is always in proportion to this unit.

With bottles holding 500 grains, 250 or 125 Grams, it is necessary to bring the weight of the liquid, whose specific gravity is sought, to 1,000 by multiplying the weight with the required multiplier 2, 4, or 8, respectively, in order to obtain the standard unit for comparison, viz., 1.

#### HYDROMETERS.

The specific gravity or, as it is sometimes called, the density of liquids is also frequently designated by the number of degrees indicated by the hydrometer—*c. g.*, B.<sup>o</sup> 18.

*Hydrometers* are instruments made of glass, consisting of a bulb filled with some heavy substance, such as shot or mercury (which maintains the instrument when immersed in the liquid in an upright position), and a graduated stem. These instruments are used only for commercial purposes, since they are not sufficiently accurate for scientific work, nor is their use recognized in the U. S. Ph., except for alcoholic liquids. They are designed for special classes of liquids, and named accordingly, alcoholometers, acidometers, saccharometers, urinometers, etc.

*Baume's hydrometer* is of two kinds: (1) for liquids *heavier* than water; and (2) for liquids *lighter* than water. Although they were the first to become extensively employed, their use is being rapidly superseded by hydrometers whose scales also give the actual specific gravities, thereby rendering conversion unnecessary.

As these standards are still in use in the arts, the following rules for converting them into sp. gravity are convenient:

For liquids *heavier* than water: subtract the degree of Baume from 145, and divide 145 by the remainder thus obtained. The quotient is the specific gravity.

For converting the specific gravity into Baume, reverse the process.

For liquids *lighter* than water: add the number of degrees to 130,

and divide 140 by the sum thus obtained; the quotient is the specific gravity. To reduce sp. gr. to B., divide 140 by the sp. gr. and subtract 130 from the quotient; the remainder will be the degree Baume.

#### SPECIFIC GRAVITY OF SOLIDS.

The specific gravity of solids is determined by *dividing the weight of the substance by its loss of weight in water.*

This loss represents the weight of an equal bulk of water and depends upon the law of Archimedes, viz.: that bodies immersed in a liquid are buoyed up with a force *equal to the weight of the liquid displaced.*

It should be borne in mind that in all calculations to find the specific gravity of solids, whether in mass or powder, heavier or lighter than water, soluble or insoluble in this liquid, the main object sought is the *weight of a quantity of water equal in bulk to the substance*, the specific gravity of which is to be found.

In determining the weight of an equal bulk of water, the methods employed must necessarily vary with the difference in the physical properties of the substances. All solids come under one of the following divisions:

(1) A mass heavier than water: Divide the weight in air by the loss of weight in water.

*Example:* A substance weighed in the air weighs 500 grains; its weight in distilled water, when completely submerged, is 400, loss 100 grains; hence the sp. gr. of the substance is 5. ( $500 \div 100 = 5$ ).

(2) Mass lighter than water: Divide the weight in air by the weight required to restore the equilibrium when weighed in water.

The substance is weighed with a body attached to it of sufficient weight to keep it immersed in the water; the heavy body having first been *counter-poised* under water, in order that the conditions shall be equal.

*Example:* A piece of iron, suspended by means of a silk thread or horsehair, attached to the end of the beam of a scale, is weighed in water contained in a beaker placed so as not to interfere with the full movement of the balance. It is *counter-poised* by the necessary weight placed upon the opposite pan. A piece of wood weighing 12 grains, in air, is attached near the iron, both being immersed in the water, but the wood being lighter, is buoyed up with a force equal to the liquid it displaces, and carries the iron upward to the surface of the liquid. To restore the equilibrium of the balance it requires an additional weight of 23 grains, which represents the weight of a bulk of

water equal to the bulk displaced by the wood. Then 12 divided by  $23=0.5217$  sp. gr. of wood.

(3) Mass soluble in water: Divide the weight in air by the *loss* of weight in some liquid in which it is not soluble, and multiply by the specific gravity of the liquid.

*Example:* A piece of sulphate of copper weighs 300 grains in the air; in oil of turpentine it weighs 186 grains, loss 114 grains; the original weight (300) divided by 114, gives 2.63, which multiplied by 0.88 (the sp. gr. of the oil of turpentine previously ascertained), is 2.3144, the sp. gr. of the sulphate of copper.

*The Specific Gravity of Powders*, as in the manipulations of the specific gravity of solids in mass, is found by ascertaining the amount of liquid the powder displaces when weighed in a specific gravity bottle.

The same principles govern and the same rules should be applied as with masses, according as the powders differ in physical properties.

# Percentage Volume and Weight.

## SPECIFIC VOLUME.

The specific volume of liquids is the *opposite* of specific gravity, and is expressed in *inverse* ratio to specific gravity.

As the specific gravity of a liquid is the weight of a certain volume of that liquid *divided* by the weight of an equal volume of water, so the specific volume of a liquid is the *quotient* obtained by dividing a given volume of water by the weight of an eqnal volume of the liquid whose specific volume is sought, thus:

$$\begin{array}{lll} \text{Water.} & \text{Glycerin.} & \text{Specific volume.} \\ 1.00 \text{ divided by } 1.25 = & & .80 \end{array}$$

The comparison of specific gravity and specific volume, which also serves to illustrate the relation that exists between the weight and the volume of different substances, may be shown as follows:

Take any vessel, preferably a flask of a capacity of a certain round number of cubic centimeters, i. e., 1000, and fill it with distilled water. If at its maximum density the water will weigh 1000 Grams; if at the ordinary temperature it will weigh a little less, because the water, having expanded, a certain quantity takes up more room than it does at the congealing point.

The specific gravity and the specific volume of water are therefore the same, water being the *unit* to which all liquids are compared.

As observed previously, water is also the *weight unit* in the Metric System, the Gram being the weight of one Cubic Centimeter of distilled water. But water is the only simple liquid which has this property; other liquids varying greatly in *density*. As referred to under "specific gravity," some liquids are lighter, and have a *lower* specific gravity; others are heavier or denser, and have a *higher* specific gravity than the liquid, water, the unit for comparison being expressed as 1.

If the 1000 C.C. flask be filled with Ether it will weigh 725 Grams, and the specific volume will be:  $1000 \div 725 = 1.379$ ; if filled with Alcohol it will weigh 820 Grams, and the specific volume will be:  $1000 \div 820 = 1.220$ .

On the other hand, if the flask be filled with Chloroform it will weigh about 1,500 Grams, and the sp. vol. will be:  $1000 \div 1500 = .666$ .

With the use of the Metric System the knowledge of specific volume has many applications.

Thus, for example, when such liquids as have been referred to

are sold by *measure*, in metric containers of one liter (1000 C.C.), or fractions, the weight of one liter is known at once from the sp. gr., i. e.: 1 Liter Glycerin=1,250 Grams. When sold by *weight*, the usual custom, by availing ourselves of the specific volume, calculated beforehand from the specific gravity, we have at once the measure of the liquid. For example:

1 Kilo. Glycerin=1000 Grams; then  $1000 \div 1.25$  sp. gr.=800 Cubic Centimeters of Glycerin.

1 Kilo. Chloroform;  $1,000 \div 1.50 = 666.6$  Cubic Centimeters.

1 Kilo. Sulphuric Acid;  $1000 \div 1.835$  sp. gr.=544.9 Cubic Centimeters.

With the old weights and measures this comparison is entirely lost, as they lack the beautiful regularity and ratio or proportion of the Metric system.

Thus the weight of 1 Pint of Glycerin is not obtained by multiplying the number of grains in the pound (av.), 7,000, with the specific gravity of the Glycerin, 1.25, because one pint of water weighs more than one pound, namely, 7,300 grains (7,292 59°F.) and the weight of the Glycerin is therefore  $7,300 \times 1.25 = 9,125$  grains. The smaller denominations are equally discordant, the grain equivalents for the ounce being: tr. oz.=480 grs.; fl. oz.=456+grs.; av. oz.=437½ grs.

The *minim* and the *grain* are alike discordant, as will be seen by dividing the number of grains in one pound by the number of grains in one pint, which gives:  $7,000 \div 7,300 = 0.959$  grain, equivalent to one *minim* instead of one *grain*.

#### PARTS BY WEIGHT

“Parts by weight” means the system by which all quantities, liquid or solid, are expressed by *weight*. It always refers to decimal numbers, 10, 100, 1000, etc., and is therefore a *percentage* system.

Owing to this fact, it is in accord with the Metric System, and is often erroneously regarded as identical with the latter. While the metric weights, because of their *decimal* proportions, are well adapted for the quantities in which parts-by-weight may be expressed, still any other system of weights, or denominations of these, may be used; provided that the same *unit* is maintained in all the parts. Thus a Formula from the U. S. Ph., 1880, in parts by weight, may be taken in any quantities as follows:

Solution of Chloride of Iron.	35	}
Alcohol . . . . .	65	
To make . . . . .	100	or drams, etc.

This system is of advantage in expressing Formulas for mixtures of *solid* substances, such as Ointments, Cerates, Plasters, etc., but it is not adapted to Formulas for *liquid* Preparations or those containing *liquids*, such as Tinctures, Spirits, Syrups, etc., because of the great

convenience and general custom of *measuring* liquids instead of *weighing* them. But the greatest objection to the parts-by-weight systems lies in the fact that all liquid preparations for *internal* use are prescribed and administered by *measure* and not by weight, and their strengths should therefore have a *uniform* relation to the ordinary liquid measures, viz.: the Minim, Cubic Centimeter, fl. Dram, etc., upon which the *dosage* is based.

Thus, in the former example, only by calculating from the specific gravity can the quantity of solution of chloride of iron contained in these respective measures be ascertained, while by the Formula of the U. S. Ph., 1890, in accordance with the Metric System, in which the liquids are measured instead of weighed, these amounts are shown at once:

*Tinctura Ferri Chloridi.*

Solution of Ferric Chloride . . . . .	250 C.C.
Alcohol, sufficient to make . . . . .	1000 C.C.

From this it will be at once observed that a certain measure of the Tincture contains always one-fourth its volume of the solution, i. e.: 10 min. =  $2\frac{1}{2}$  min. solution; 1 C.C. = 0.25 C.C. solution. This same uniformity exists throughout all the liquid preparations (except in a few of the Solutions and Syrups) and any Tincture, such as Tincture of Opium of which 100 Cubic Centimeters are made from 10 Grams of Opium, will represent 1 decig. (0.1) in one C.C., or 1 grain in 10 minimis (approx.) of the drug.

The advantages of this uniformity in *measure* have been so clearly recognized that the parts-by-weight system of the U. S. Ph., 1880, was discarded for the Metric System in the U. S. Ph., 1890, with the few exceptions noted.

PERCENTAGES.

The strength of many substances and their preparations are now mostly expressed in *percentages* (from *per* for, *centum* one hundred) abbreviated *per cent.* and p. c.; also indicated by the sign %.

*Per cent* is a decimal proportion, which refers to the whole as parts of 100; just as of our money one cent is the one-hundredth and one dime the one-tenth of one dollar; and in the Metric System one centigram is the one-hundredth, one decigram the one-tenth of the Gram, and the Cubic Centimeter the cube of one centimeter, therefore the one-thousandth of the cube of the decimeter or the Liter.

Any percentage amount is therefore readily converted into its respective quantity in the metric terms, for example: One Kilo. of Opium contains 12.5 per cent of morphine. How much morphine does it contain? Multiply the Kilo., first reduced to Grams, by the percentage number, and then point off three figures from the right to represent the decimals for the answer:  $1,000 \times 12.5 = 125$  Grams of morphine.

With the *avoirdupois* and *apothecaries'* weights it is necessary to reduce the

quantities to the unit, the grain; thus: one pound and a half, av.,  $10,500 \times 12.5 = 1312.5$  grains of morphine; or 10 ounces, apoth.,  $4800 \times 12.5 = 600$  grains of morphine.

The answers in each case should be transposed to the respective highest denominations of the two systems—ounces and drams.

#### PERCENTAGE SOLUTIONS.

Percentage is also applied to liquids, for example, to indicate the strength of acids, in anhydrous, or real acid, as in Acid Sulphuricum, U. S. Ph., 92.5 *per cent*: the strength of *AEther*, 96 p. c.; Alcohol, 91 p. c., etc. Nearly all the official Solutions have their strengths expressed in percentage.

In all liquid chemical products the strength is rendered in percentage by *weight*, because percentage means that all the component parts referred to in *percentage* must be compared by the same standard as the *whole*. That is, they must either *all* be *measured*, or *all* be *weighed*; if the percentage is based on *measure*, *all* the parts must also be *measured*, an operation not practicable with solids. But as there is no practical difficulty in weighing liquids, particularly on the large scale, for the purpose of attaining the greatest scientific accuracy, this basis has been adopted for liquids, which from their character are not intended to be taken internally without further preparation.

Solution of Ferric Chloride is not given internally, but the Tincture, prepared from it, is; hence the convenience of knowing its strength by *measure*. The Solution, on the other hand, is prepared by *weight*, in order to attain its correct specific gravity from which its percentage strength is chiefly determined.

For pharmacal practice it is necessary to refer the percentage strength of solutions intended for dispensing purposes to *measure*; that is, *solids by weight and liquids by measure*.

In the administration of remedies the physician is concerned only as to the dose represented in the ordinary fluid measures—minim, fluidram, cubic centimeter, etc.

In preparing solutions extemporaneously (as needed), therefore, the pharmacist *weighs* the solid and then adds sufficient of the liquid used (the solvent) to dissolve it, in order to make it up to a certain *measure* or volume, and not *weight*, unless so directed.

Thus, if 1 fl. oz. of a 2 p. c. solution of phenol (carbolic acid) is required, the quantities are:

By volume,  $480 \times .02 = 9.6$  grains phenol.

By weight,  $456 \times .02 = 9.12$  grains phenol.

Here again the uniformity and commensurability of the Metric System become readily apparent. Any percentage solution may be expressed in 1 Gram *for each per cent* in each 100 Cubic Centimeters.

Thus 250 C.C. of a 4 p. c. solution of Boric Acid:  $250 \times .04 = 10$   
Grams Boric Acid.

All percentage solutions, whether by weight or by volume, should be prepared according to the *Metric System*, as it will save calculation and serve to avoid errors.

Every student should have access to, or supply himself with, Metric weights and measures.



## Heat.

The subject of heat is one of great importance to pharmacy, because only by the right use of this agent can we perform successfully many of the more important operations involved in the preparation and dispensing of medicine. But in order to understand its proper management, it is important to know something of its nature and its laws. Only such a brief treatment of the subject will be given here, however, as will have important bearings on the practice of pharmacy.

Heat was formerly regarded as matter, and was classed along with light, electricity and magnetism, as "imponderable matter," in distinction from ordinary matter, which is ponderable, or capable of being weighed. But this view is now known to be erroneous; heat, light, electricity, and magnetism are all modes of motion, and heat may be defined as *that mode of motion which is capable of producing in us the sensation of warmth.*

Every mass of matter is supposed to be made up of very minute particles called *molecules* (from *molecula*, Lat., small matter); these molecules are not in absolute contact with each other, even in the most compact matter, but are separated from each other by distances varying under different circumstances, and in different states of the same substance; moreover, they are in a state of vibration, and this vibration it is that gives rise to the phenomenon we call *heat*. When the vibration is slow the body is said to be *cold* or to have a *low* temperature; when rapid it is said to be *hot*, or to have a *high* temperature. As there are no bodies without molecular vibration there can be none that are absolutely without heat, and the terms heat and cold, therefore, are only relative, expressing different degrees of molecular vibration.

It is a great general law that masses *expand* from an *increase* and *contract* by a *decrease* in their temperature. We can easily understand how this must be so, when we remember that a number of molecules vibrating with great intensity will describe longer distances and require more room than the same number of molecules vibrating with less intensity, and therefore describing shorter distances.

The expansion of Liquids is of especial importance in pharmacy, since they are usually kept in glass containers, which are easily fractured through the pressure exerted upon them when filled with expanding liquids. The expansion of water at the freezing point has already been noted; likewise such watery solutions as are liable to freeze, and thus expand. Sulphuric acid has been known to freeze and burst the carboy containing it. Liquids

of low specific gravity expand quickly through elevations of temperature. Thus, 1,000 C.c. of the following expand to the number of C.c. named for each  $10^{\circ}$  C. elevation of the temperature, viz: Alcohol 1011, Benzin 1013, Ether 1018, etc.

Matter exists in three states, termed states of aggregation, that of *solid*, *liquid*, or *gas*. These different states depend upon the relative freedom of movement of the molecules.

In *solids* the molecular attraction is so much stronger than the repellent force due to the molecular vibration, that the molecules are not easily displaced when external force is exerted upon them; in other words, the solid condition is due to the preponderance of the force of molecular attraction over the opposing force of heat or molecular vibration.

In a *liquid* the two forces nearly balance each other; the molecules not being firmly held in the embrace of each other's attraction glide readily over one another, and liquids, therefore, readily take the shape of the containing vessel.

In a *gas* the molecules are so far apart that they are wholly unrestrained by molecular attraction and free to obey the repellent force of heat; therefore, gases tend to expand indefinitely. If restrained, they exert pressure on the walls of the containing vessel, and this pressure is supposed to be due to the impact of the molecules. If the walls of the vessel are unyielding, the elastic molecules rebound without losing their energy; if, however, they yield, the molecules lose a portion of their moving power, and so the well-known fact of cooling by expansion is accounted for.

#### CONDUCTION OF HEAT.

Heat may be transferred from one body to another in two different ways:

- (1.) By conduction. (2.) By radiation.

(1.) *Conduction*.—When one end of a bar of iron is placed in the fire the heat travels from molecule to molecule up the bar to the other end; this is called conduction. Different kinds of matter, or the same kinds in different states, conduct heat with different degrees of facility. Gases are worse conductors than liquids and solids, because their molecules, being farther apart, can communicate their motion less rapidly to each other than in liquids or solids.

When heat is applied to the bottom of a vessel containing a liquid, the layer next to the bottom expands, and, being lighter, rises to the surface and a cooler layer takes its place, which in turn is heated, creating ascending and descending currents in the liquid, which result in the heating of the entire mass. This is a form of conduction which has been termed *convection*. Gases may be heated in this way, a draft in a chimney is created by a fire in the same way, and it is chiefly by this means that the atmosphere is heated by the sun's rays. But it is obvious that solids, whose molecules are strongly held by the molecular attraction, cannot be heated by this means.

A knowledge of the leading facts in regard to the conduction of heat is of much practical importance to the pharmacist. Solid substances differ very widely from each other in their power of conductivity. The metals, on the whole, are much better conductors than other solids, but even metals differ widely among themselves.

If the conducting power of silver (the best conductor known) be taken as 100, that of copper will be 73.6; tin, 14.5; iron, 11.9; lead, 8.5; platinum, 8.4, and bismuth, 1.8. Silver is, therefore, nearly sixty times as good a conductor as bismuth, but bismuth is eighteen times as good a conductor as porcelain, and the latter is a far better conductor than wood. On a cold day, in an unheated room, the different objects in the room are practically at the same temperature, but the handle of the poker feels cold, the marble mantle less so, a chair-back less so still, and the Brussels carpet scarcely at all cold to the touch. If the temperature be very low in the room these differences will be very decided, and yet they are due solely to the very different power these bodies have of conducting heat from the hand.

So, also, on the other hand, if a piece of iron and one of soapstone each be heated to the temperature of 100°C., the latter will seem much cooler to the touch than the former, because it is a worse conductor. For reasons like these, metallic vessels that are to be subjected to high temperatures, are provided with wooden or porous earthenware handles, ice is wrapped in woolen blankets to keep it from melting too rapidly, or a hot body is wrapped in similar porous metal to prevent it from parting with its heat too rapidly; and for this reason houses are built of wood or other non-conducting material, woolen used for winter clothing, and arctic mammals are provided by nature with a covering of thick, soft fur.

For further information upon the subject of "Heat" students may refer to Trowbridge's "Essentials of Physics," and Parrish's or Remington's "Pharmacy."

(2.) *Radiation.*—This term is applied to that mode of transference of heat derived from heated objects by conduction through the atmosphere, as the heat from combustion in a stove, etc.

The earth heated by the sun's rays is also an example of radiation. Heat is found to travel through space with the velocity of about 186,000 miles per second, and it is found, moreover, that air is not the medium that conveys it, since it is radiated with equal facility through space devoid of air, and it is incredible that air should fill the entire space between the earth and sun.

#### THE ETHER.

As we cannot picture to ourselves a force existing apart from matter, we cannot conceive of heat coming from the sun to the earth through an absolute vacuum. Matter of some kind must be the vehicle of the force. Hence the hypothesis of the *ether*, a substance of exceeding tenuity, but highly elastic, which not only fills the spaces between the heavenly bodies, but also those between the molecules of all substances. It is along this that the heat is supposed to be propagated in waves by molecular vibrations of the heated body, much as sound is propagated in waves through the air by

a sounding body, or ripples on the surface of a pond by a stone thrown into it. The ether waves set in motion by the rapidly-vibrating molecules of a hot body can in turn heat a cooler surface on which they impinge, by setting its molecules into more rapid vibration, as, for instance, the sun's rays heat the earth.

The *waves* that traverse the ether are not all precisely alike. Their effects are quite different in many respects, although the only physical difference between the waves themselves seems to be one of wave-length. Three kinds are distinguished—*dark heat waves*, *light waves*, and *actinic waves*. The dark waves have the longest wave-length, possess heating power, but do not affect our sense of sight; the light waves are shorter, affect our sense of sight, and produce also heating and chemical effects; and the actinic waves are shorter still, do not affect our sight, possess little heating power, but produce chemical effects.

#### THERMOMETERS.

The extent of the expansion or contraction of a given substance by the addition or subtraction of heat, expressed in parts or degrees, constitutes the usual method for estimating the degree of sensible heat imparted by a body—in other words, the degree of its temperature.

Since the expansion and contraction in volume are constant with the changes in temperature, the extent of variation may be best determined by the substances usually employed—mercury, because of regular expansion, and because it boils only at a very high temperature; and alcohol, because it does not solidify at the greatest known cold.

Thermometers (from *Thermæ*, Gr., heat, and *metron*, Gr., measure) are instruments made of a glass tube, with a bulb at one end filled with mercury or alcohol, the tube being attached to a graduated scale; the mercury rises and falls in the tube as its volume is increased by heat or decreased by cold.

Unfortunately, no less than three standards have been adopted for thermometers, termed respectively: Reaumur, Celsi, and Fahrenheit.

In Reaumur's scale, zero is at the freezing point of water, and 80° the point at which water boils.

In the Celsi or Centigrade (from Celsius, its discoverer), the zero point is also that of freezing water, but the boiling point is fixed at 100°.

In Fahrenheit's, the freezing point of water is at 32°, and that of boiling water is at 212°; hence the number of degrees between these two standard points in this thermometric scale is 180, instead of 80° and 100° in Reaumur and Celsi respectively. The point 32°, taken for the freezing point of water in Fahrenheit, instead of 0 as in the other scales, is explained by the fact that it was the lowest degree of

cold (obtained from a mixture of snow and ammonium chloride) known up to the time of the construction of the Fahrenheit scale.

The Fahrenheit thermometer is almost exclusively used in the United States, except for scientific use. The Celsius is becoming the standard authority in scientific work, owing to its centesimal scale being in harmony with the metric system of weights and measures and is given the preference in the U. S. Ph., '90. It will eventually supersede the other scales. Reaumur's is chiefly employed in Germany and therefore also extensively in the chemical industries.

In converting the degrees of one scale into either of the others, we must find a number which is divisible into the three respective numbers: 80, 100, and 180, without any fraction. Such a number is 20, and the quotients obtained, viz.: 4, 5, and 9, express the number of degrees in each scale equivalent to the same degree of temperature. In Fahrenheit, the 32° between freezing-point and zero must invariably be added when the degrees of other scales are converted into it, after the degrees are made equivalent to the proportion just named.

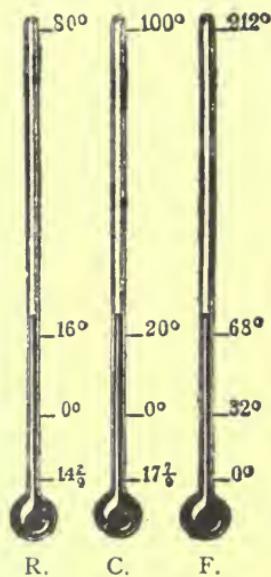
In reducing Fahrenheit to Celsius and Reaumur, the 32° are first subtracted, and then the remaining degrees are reduced to the equivalent proportions.

*Examples.*—To convert 15 Celsius degrees to those of Fahrenheit, multiply by 9, divide by 5, and add 32; equal to 59°F. To reduce 40 Fahrenheit degrees to those of Celsius, subtract 32, multiply by 5, and divide by 9; equal to 4.44°C. To reduce F. to R., subtract  $32 \times 4 \div 9$ . [For table of Thermometric Equivalents, see U. S. Pharmacopœia.]

Higher temperatures than 300 or 400°C. are measured by the pyrometer (from *pyr*, Gr., fire) an instrument in which the degrees are expressed by the expansion of a metallic rod (platinum). The following terms are used to designate temperatures in the working of metals: Cherry red, 500°C.; red heat, 700°C., and white heat, 1000°C.

#### LATENT HEAT.

From the fact that the temperature of a substance ceases to rise while it is melting, even though heat still be applied to it, we readily see that much heat must disappear in the process. This is said to become *latent* (from *latere*, Lat., conceal). Latent heat differs physically from free or sensible heat, in that its presence *cannot be determined by the senses or by the thermometer*.



When, however, certain chemical actions take place, or the state of aggregation changes from a *gaseous* substance to a *liquid*, or from a liquid to a *solid*, the *latent* heat so-called is rendered *sensible*.

We may regard the particles of any body as being subjected to two opposing forces—*cohesion*, which tends to draw them more closely together—and *heat*, which tends to drive them farther apart.

If the heat be *increased*, the body under its influence further expands, until at a given temperature the particles, driven still wider apart, resolve the substance into a *liquid* state; finally, in the case of many substances, the heat entirely overcomes the cohesion, and the particles fly apart in the form of *vapor*. When the source of heat is removed, and that already acquired by the substance has been imparted to surrounding objects, cohesion again comes into play and the substance assumes the *liquid* or the *solid* state.

The heat absorbed by water, for example, is expended in forming it into vapor; when such vapor comes in contact with a colder body, such as air currents, the latent heat is abstracted and the water resumes its original liquid state. When the vapor is confined by the pressure of a steam boiler it may be heated to a temperature considerably higher than the boiling-point, and thus possesses still greater heating power.

**STEAM.**—One cubic inch of water by boiling is converted into about 1,700 cubic inches, or nearly one cubic foot, of steam, and in the mere conversion of a cubic inch of water at 100°C. into steam at the same temperature an amount of force is exerted which is equivalent to lifting about 27,000 pounds one foot high.

Steam, as a source of heat, contains 520°C. of latent heat. By contact with a cold surface it is condensed to the liquid form and this heat is given out. Theoretically, steam in the act of condensing will raise the temperature of nearly ten times its weight of water 55°C. Twenty pounds of steam condensed in 200 pounds of water at 44°C. will raise the temperature of the water to 100°C. if no loss is sustained.

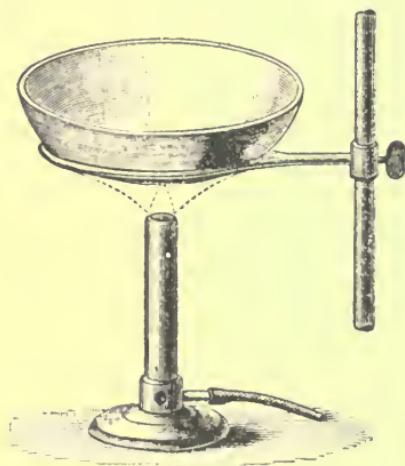
#### PHARMACEUTICAL SOURCES OF HEAT.

The sources of heat are various. One great source of heat is the sun, and some is derived from the earth's interior, but most of that of terrestrial origin comes from the transformation of other forms of energy; as, for instance, mechanical energy is converted into heat when a cannon ball strikes a target, or when the brakes are applied to a moving train.

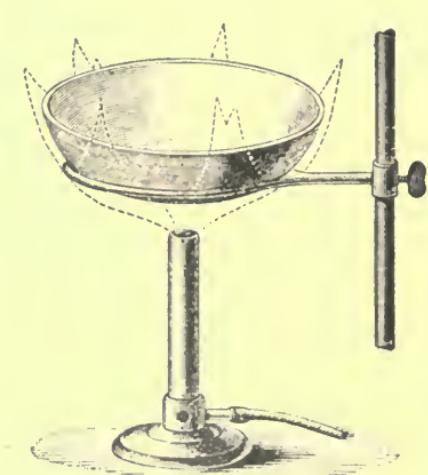
*Electricity* is converted into heat when a strong current is made to pass through an inadequate conductor, as in the various forms of the electric light; and *chemical* energy is converted into heat in all cases of combustion, as when a match is kindled, or coal is burned.

In the practice of pharmacy *combustion* is the most important source of heat. The substances used are the ordinary combustible materials, such as coal, wood, alcohol, kerosene, and coal-gas. The best, perhaps, is coal-gas, if it can be afforded, as it is convenient, safe, cleanly, and heat of almost any required degree of intensity can be obtained by means of it.

The best gas stoves are so constructed as to yield a nearly colorless flame, and one whose heat is very intense. These objects are accomplished by admitting a stream of air in such a manner as to cause it to mingle with the gas below the flame, making the combustion more rapid and complete.



BUNSEN BURNER,  
Properly regulated, burning  
with bright, blue flame.



BUNSEN BURNER,  
With excessive flame.

The Bunsen burner is constructed upon this principle. It consists of a tube serving as a burner whose lower portion has an opening closed with a ring. By moving the ring, air is admitted (which should mix with the gas before it is ignited) and serves to regulate the draft. It should burn with a bluish-colored flame, which, through the complete combustion of the gas, yields but little light and no soot. The highest heat is given by the *tip* of the flame.

# Vaporization.

When a solid or liquid body changes into the gaseous form it is said to undergo *vaporization*.

Vaporization is that process of transformation whereby the state of aggregation changes into vapor or gas. This change is often effected by relatively low temperature, when the result is called *vapor*. Higher temperatures drive the molecules apart to their greatest distances, when the result of the change is termed *gas*.

Vaporization depends upon the abstraction of heat from surrounding bodies, as in the transformation of water into vapor, by absorption of heat from the Earth. This heat, rendered latent in converting the liquid into vapor, is abstracted by the colder atmosphere in the upper air-currents and the vapor is transformed into its original liquid state—water, or if exposed to a low temperature it congeals or freezes and then forms snow. This natural phenomenon of rain is in fact the best practical illustration, not only of the effects of heat in changing the state of aggregation, but also in demonstrating the various processes depending thereon. Upon the general process of vaporization the following pharmaceutical operations are dependent:

*Evaporation* is the process of vaporization applied to a liquid or liquid mixture for the removal of liquid, either partly to reduce its bulk or volume—called *concentration*—or its entire removal, so as to leave a solid *residue*.

*Distillation* is the preceding operation extended so as to transform the vapor into the liquid state by bringing it in contact with a cold surface—called *condensation*—and collecting the liquid; the *distillate*.

These operations each have several modifications as applied to different substances, and with reference to the vaporized, or the solid, substance, being the object sought by the particular method employed.

## EVAPORATION.

Evaporation is the term generally applied to the pharmaceutical operation by which a solution is reduced in volume or concentrated by means of heat.

The *concentration*, being due to the vaporization of the liquid portion, is hastened by *stirring*, which facilitates the evaporation of liquids for two reasons:

(1) A larger surface is thereby presented to the action of the heat and also to the action of the air.

*The greater the extent of the surface the greater and more rapid the rate of evaporation.*

The best illustration of this principle in practice is the method employed of evaporating thick or viscid liquids, such as the so-called Solid Extracts. In Extract of Malt the liquid extract is spread over as shallow a surface as possible. The solutions from which the so-called Scaled Salts of Iron, etc., are prepared are first evaporated to a syrupy consistence and then spread in thin layers on glass-plates in order to remove the remaining liquid. In this way the greatest possible surface is presented both to the source of heat and where the air comes in contact with the vapor and aids in its removal.

(2) Agitation favors evaporation by renewing the air in contact with the surface of the liquid.

The air above a vaporizable liquid soon becomes charged with vapor, and the evaporating process goes on slowly unless the air be renewed, and the more rapid the removal of the saturated air the more rapid will be the evaporation.

Partly on this principle and partly on the principle that the boiling point of liquids is lowered as the atmospheric pressure on the surface is reduced, the process of *evaporation in vacuo* is performed. While under the ordinary atmospheric pressure of 15 lbs. to the square inch, water boils at 100°C. (212°F.), when heated in a closed vessel and the air above its surface exhausted, it boils at 27° or 32°C. (80° or 90°F.) below the usual temperature, or about 55°C. (132°F.). The process also has the advantage that it permits rapid evaporation in a comparatively low temperature.

The following considerations should also be observed in conducting the process of evaporation:

The evaporating vessel (dish) must be *shallow*, so as to present as great a surface as possible both to the heat and to the air which carries off the vapor.

The evaporating dishes should be made of material from which the residue, if solid, may be removed without contamination. For this reason porcelain or enameled dishes are to be preferred to those of soft metal, such as copper.

The heat should be carefully regulated at its source, to avoid overheating the substance.

*Vegetable* principles are much more easily impaired or destroyed by heat than *inorganic* or mineral substances; these latter, when in solution, do not require any special precaution, since they may usually be subjected to great heat without undergoing decomposition.

In evaporating a substance, the highest degree of temperature to which it may be exposed without injury must be known, and the source of heat employed accordingly. The so-called Baths are therefore employed as the sources of heat for evaporation, as by this means the temperature may be easily regulated and kept within proper limits.

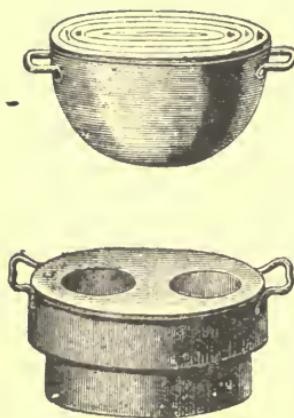
## BATHS.

The principle upon which the baths are constructed is, *that all matter gives out heat to surrounding matter.*

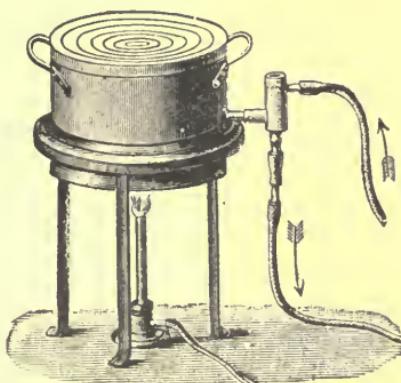
When, therefore, a liquid, such as Water, is heated, it communicates its heat to any substance with which it comes in contact, until both have the same temperature.

For the Baths, or *Media*, as they are called, any substance may be employed, but the following are those in use in pharmacy:

*Water-Bath.* — Water boils at 100°C. (212°F.) and through its use in the form of a bath any substance may therefore be heated to this same temperature.



WATER BATHS.

WATER BATH,  
With Continuous Water-supply.

It consists of two vessels—one fitting within the other in such a manner that a space of greater or less extent is left between them. This space is nearly filled with water, and the substance to be evaporated is placed in the inner vessel. It is evident that with such an arrangement the liquid in the inner vessel cannot be heated above the temperature of 100°C. (212 F.); in fact, in practice this temperature is never attained, and if it be a substance liable to decomposition at any higher temperature, the process becomes a safeguard against such an occurrence. The method also admits of very gradual and even application of heat.

*Steam-Bath.* — The use of steam heat in certain forms of evaporation is a great convenience, since it affords a range of temperature proportionate to its pressure, or to the pressure which the vessel is calculated to sustain.

The vessel or apparatus for a steam bath consists of two pans, riveted together at the upper edge—jacketed—having an inlet-pipe to admit the steam into the space between the two pans just below the point where they

were joined, and an outlet-pipe at the bottom, allowing the escape of the condensed steam or water. Both pipes must be provided with stop-cocks to regulate respectively the inflow and escape of the steam.

Steam may also be employed for heating purposes, but not for evaporation, without being confined, called "live steam," by placing the vessel containing the substance to be heated loosely into another vessel so that it rests upon the rim of the latter, into which the steam is admitted.

The term "gentle heat" the U. S. Ph. defines as meaning any temperature between 32° and 38°C. (90 and 100°F.). Other terms occasionally employed are "moderate heat" 55° to 70°C. (130 to 165°F.) and "temperate heat" 15°C. (59°F.).

*Saline Baths.*—Saturated solutions of various salts, in order to be brought to the boiling point, require a greater amount of heat than does water. For example, the boiling point of a saturated solution of sodium chloride is 108°C. (227°F.); sodium borate (borax) 105°C. (222°F.); ammonium chloride, 114°C. (237°F.); potassium nitrate, 115°C. (240°F.); sodium acetate, 124°C. (256°F.), and calcium chloride, 179°C. (354°F.).

The use of these baths is indicated when it is desired to heat a substance a few degrees higher than can be done by the water-bath, and also when a very regular heat is desired, since the temperature in these baths, under a uniform heat, does not change so long as the water is replenished sufficiently to hold all but a small portion of the salt in solution.

When it is desired to heat a substance above the temperature attained by the Water or Saline Baths, and yet limit the heat to a temperature between 150 and 300°C. (300° and 572°F.), various substances boiling at a high temperature have been employed. Of these the fixed Oils and Glycerin are objectionable owing to their decomposition.

The *Petrolatum* or *Paraffin Bath* should be used whenever temperatures between the degrees mentioned are wanted.

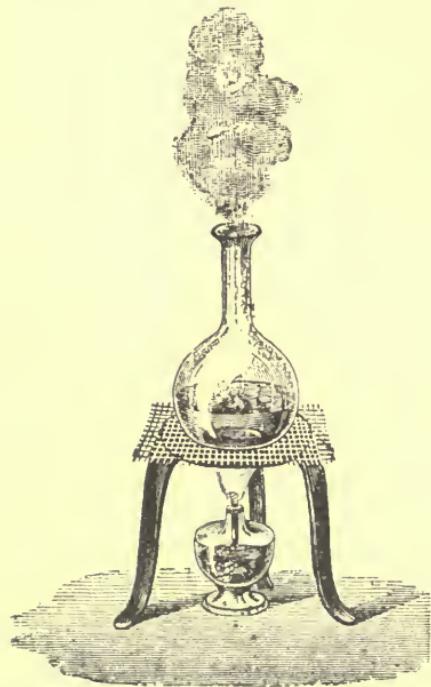
The *Sand Bath* is employed when an extreme heat is desired, but when a naked fire would not yield a constant or regular temperature.

It consists simply of a layer of dry sand placed in a shallow-iron dish, in which the vessel to be heated is imbeded. A comparatively thin layer of sand will be sufficient to equalize the heat and prevent a sudden rise in the temperature, which might result in fracturing the vessel or injuring the product.

## Boiling.

When vaporization occurs only on the surface of a liquid the liquid undergoes evaporation, but when vapor is formed throughout the liquid, such liquid is said to boil.

Water, on attaining the temperature of  $100^{\circ}\text{C}.$  ( $212^{\circ}\text{F}.$ ), enters into a state of *ebullition*; a large number of bubbles of vapor, or steam, are produced in the part of the vessel exposed to the heat, which rise through the liquid, violently agitating it as they burst. This is termed *boiling*.



BOILING.  
Showing Vapor.

The point at which this ebullition commences is that at which the tension of the vapor becomes sufficient to overcome the pressure of the atmosphere; hence, if this pressure be increased the boiling point will be raised. Thus, the boiling point of water is  $100^{\circ}\text{C}.$  at  $30^{\circ}$  barometer; when the mercury column in the barometer falls, indicating diminished pressure of the air, the water boils at a lower temperature. This also explains how liquids may be brought to the boiling point by the removal of all pressure, as boiling under vacuum.

### THE BOILING POINT.

The determination of the boiling point of liquids is very important, since boiling discloses a physical property usually dependent upon the chemical constitution of the liquid, and therefore frequently is an index to its identity, strength or purity.

For this reason the boiling point is one of the characteristics of liquids, and is usually given in the U. S. Ph. directly after that of the specific gravity.

It varies considerably, from that of Ether at  $37^{\circ}\text{C}.$  ( $99^{\circ}\text{F}.$ ) to that of Sulphuric Acid at  $338^{\circ}\text{C}.$  ( $640^{\circ}\text{F}.$ ).

To determine the boiling point the liquid is brought to boiling in a test-tube or other proper vessel, then inserting a bulb thermometer in the vapor just above the surface of the liquid for a few minutes; the degree of heat indicated by the mercury column after it has become stationary is the boiling point of the liquid.

It is important to note that the material of the vessel and its thickness, together with the condition of its interior surface, influence the temperature of the boiling point; thus, water contained in a thick porcelain dish will boil at 103°C. (215°F.); in a glass vessel, which has just previously contained sulphuric acid, at 105°C. (218°F.). Owing to this lack of uniformity, it is better to take the temperature of the escaping vapor immediately above the liquid rather than that of the liquid itself, although if test-tubes be used the boiling point of the liquid itself may be taken with results that closely approximate correctness.

In vessels composed of materials which are *good conductors* of heat, *e. g.*, metals, a liquid can be brought to the boiling point much more quickly than in porcelain, earthen or glass vessels, which are *poor conductors* of heat. Heat is more readily absorbed by substances presenting dark and rough surfaces than by those having light-colored and smooth exteriors. A liquid is therefore more quickly heated in a vessel of unpolished metal than in one having a smooth or brightly-polished surface.

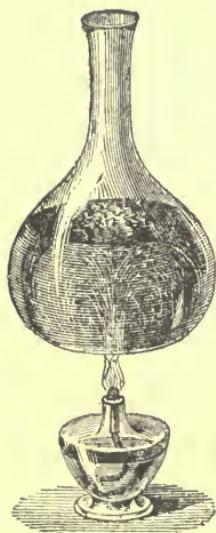
Another important effect of heat upon substances is to cause them to expand. The expansion is greatest in gases, and least in solids. Imperfect conduction, in conjunction with expansion produced by the sudden application of heat, is the well-known cause of the breaking of glass and other vessels of similar fragile material used in the pharmacy.

Glass-flasks and earthenware vessels, such as porcelain evaporating dishes, are to be handled very carefully for this reason. Such vessels are usually made very thin in order to diminish the liability to breakage from sudden and unequal expansion. Heat rapidly passes through the walls of a thin glass vessel, and no great strain is produced upon the glass by unequal expansion; also the thinness of the vessel facilitates the rapid and equal heating of the contents. But these advantages are not gained without the corresponding disadvantage of rendering the vessel more liable to be broken by careless handling.

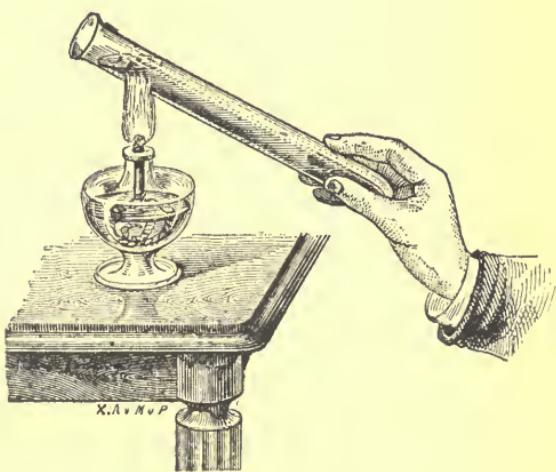
Test-tubes filled with cold water, owing to the exceeding thinness of the glass, may be placed directly in the flame without much danger of breakage; but larger glass vessels, like Florence flasks and beaker glasses, must be heated with more caution when filled with cold liquids, owing to the greater thickness of the material. Porcelain and enameled vessels have a decided advantage over glass vessels, since they are more substantial, not so easily fractured by sudden changes of temperature, and they withstand the action of acids quite as well as glass. They are frequently "cracked," however, but this is generally the result of attempting to heat the vessel first and then pouring into it a cold substance, a thing which should never be done under any circumstances.

It is often desirable to use hot water in cleaning glass bottles, graduated measures, or other glass dishes. This operation, unless conducted intelligently, is almost certain to result in disaster. A simple and perfectly safe method is first to thoroughly wet the interior walls of the vessel with cold water, then boiling hot water may be poured into it without danger of fracture.

Fragile vessels, such as glass flasks and beakers, should never be placed, when hot, in contact with good conductors, such as counter or table-tops made of marble or metal, since the rapid abstraction of heat from a portion of the glass, and not from the rest, will produce a strain which will almost invariably result in fracture.



BOILING,  
Showing Currents.



BOILING IN A TEST-TUBE,  
Of upper portion of Liquid.

The tops of tables used in the laboratory should, therefore, be made of wood, or some other non-conducting material, or the hot glass dish should be set down on paper, cloth, or some other soft, non-conducting substance, such as rings of rubber, called grommets.

In boiling without pressure in an open vessel the temperature of a liquid can never be raised above its boiling point, as all the surplus heat received is employed in evaporating the water, except under the conditions above noted. When a closed vessel is employed, the pressure may be increased and a much higher temperature attained.

Advantage is taken of this fact in pharmacy, when boiling water is desired quickly, as, for example, in making decoctions or infusions. The vessel used for heating the water in such cases should be covered.

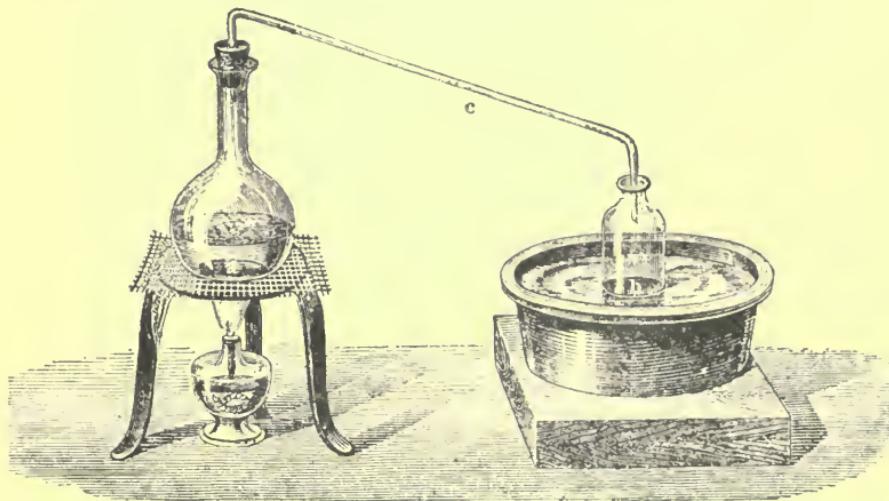
# Distillation.

Distillation is the process whereby a liquid substance is obtained or separated from other substances by means of *evaporation and condensation*. The product is termed a *distillate*.

The vaporization of a liquid for the purpose of distillation is usually conducted in a vessel especially constructed for distilling, termed a *still*.

The Still consists essentially of a *retort* and a *condenser*.

The *retort*, containing the liquid to be distilled, commonly consists of a vessel rounded below and contracted into a neck above. The neck or outlet-pipe should, in order to facilitate the escape of the vapors into the condenser, gradually curve downward.



DISTILLATION FROM A FLASK.

The simplest form of distillation is effected by the use of a Flask, fitted with glass-tubing, but this is adapted only to highly volatile liquids and for operations on a small scale.

The distillation of acid liquids must be conducted in *glass* retorts and may be successfully performed without the use of other apparatus than a Retort and a Receiver.

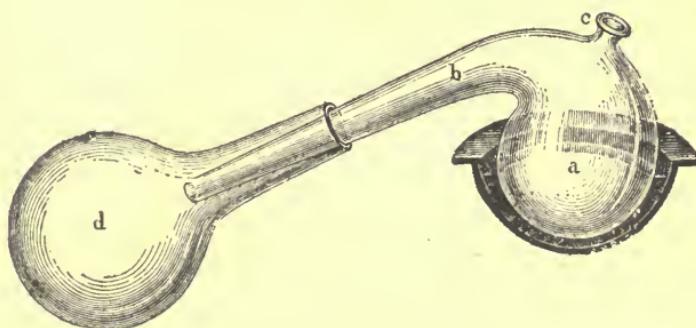
The vapor may be condensed in the neck of the retort by covering its entire length with thick cloth, kept constantly cold by the application of ice-cold water. If care be taken that every particle of vapor be condensed, before it reaches the opening which dips into the receiver, it is not even

necessary that the joint between the neck of the retort and the receiver be made tight. The receiver should be surrounded with ice. By this method explosions due to incondensable gases may be avoided.

*Retorts* employed in distilling acid or corrosive liquids and substances requiring a high temperature are usually made of glass.

They are either *plain* retorts made in one piece with one opening at the end of the elongated neck, or furnished with a small aperture at the neck provided with a ground-glass stopper, when they are called *tubulated*. The purpose of this aperture (*tubulure*) is to enable the operator to introduce fresh quantities of the substance to be distilled and for the insertion of a thermometer.

In retorts not tubulated, this procedure is very difficult and inconvenient, because the liquid cannot be poured into the retort without placing it in an upright position, thus disarranging the whole apparatus. By means of a *funnel-tube* (a glass tube with a bell-shaped end) the retort can easily be filled or replenished through the tubulure.



RECEIVER AND RETORT.

The *Adapter* is a short tube, sufficiently wide at one end to receive the end of the still or retort, gradually tapering to a width which admits it into the neck of the receiver.

*Condensation*.—The vapor formed in evaporation by exposure to a cold temperature is converted into a liquid—*condensed*.

In distilling it is necessary to use artificial means for condensing the vapors, since the effect of cold air alone would be too slow and unreliable.

The *Apparatus* for effecting condensation is termed a *condenser*.

A condenser is a tube or coil of considerable length attached to the neck of the still, for carrying the vapor through a cold substance—usually water—and after being condensed into liquid form to convey it to the receiving vessel.

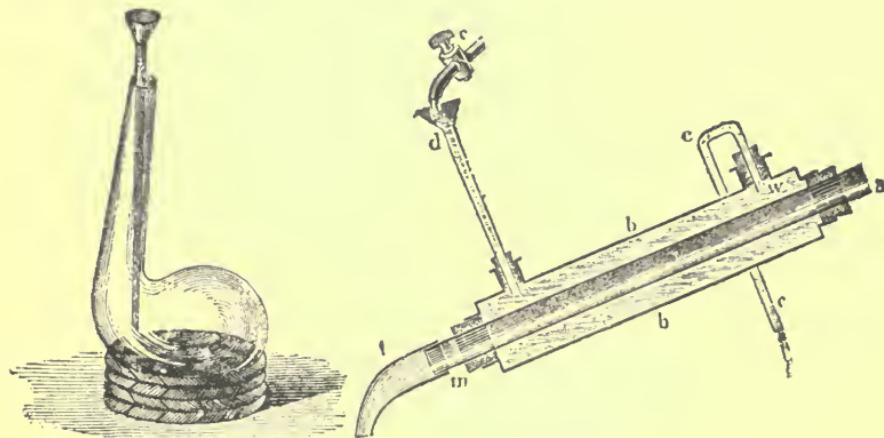
The usual forms of condensers are:

The *worm*, which consists of a coil of tubing, generally of copper or earthenware pipe, but sometimes of glass, and placed in a tub of running water, and

*Liebig's Condenser*, which consists of two tubes of unequal diameter, fitted one within the other, the intervening space being filled with cold water.

As in evaporation, the greater the surface to which the vapor is exposed, the greater the condensation. This principle has been taken advantage of in the construction of various condensers, such as the manifold Liebig's (Remington's), and Lloyd's.

One of the most effective condensers is that known as Mitscherlisch's, which consists of a double cylinder surrounded by cold water.



FILLING RETORT.

LIEBIG'S CONDENSER.

*Fractional Distillation* is the process of distillation applied to the separation of two or more liquids having different boiling points.

The method usually employed in this process is to insert a thermometer in the boiling liquid, and collect the distillate in different vessels, as it comes over at different temperatures. The separation may also be effected by condensing the vapor in a series of receivers exposed to different temperatures.

In pharmacy, mixtures of ether, alcohol and water are thus separated, owing to the great differences in their boiling points (or temperature for vaporization) and the corresponding differences in temperature necessary for condensation. In the arts fractional distillation is largely applied to coal-tar, oils, petroleum, etc.

#### PHARMACEUTICAL STILLS.

The distillatory apparatus best adapted for pharmacal purposes are made of metal, preferably tinned copper.

In the oldest form of these, the condensation is effected by cold water contained in a jacketed top, surmounting the boiler and the pan containing the liquid to be distilled, which together constitute a water-bath. The top is rendered vapor-tight by a water-joint, but owing to the evaporation of the water, the joint is preferably made of some non-vaporizable substance, such as Glycerin, or Petrolatum. The most common and cheapest of this style of Still is the Phœnix (made by Whitall, Tatum & Co.).

In conducting the process of distillation the following general rules should be observed:

(1) The apparatus must be vapor-tight. Since the object of the operation is to recover the volatile portion, any loss of vapor will necessarily reduce the quantity of the product—the distillate. In the pharmaceutical stills where the two parts of the still are connected by flanges, these should be substantially made and fit upon each other perfectly true, so that when screwed together they will be tight. A piece of wet twine laid between the flanges makes a thoroughly vapor-tight joint when these are clamped together.

(2) The condensation must be complete. There must be an abundant supply of cold water around the condensing pipe, sufficient to condense all the vapor, otherwise loss will result. The water surrounding the vapor in the condenser should always be renewed as soon as it becomes warm.

(3) In heating the contents of the still, care must be taken that the increase of temperature be gradual. The still above described is usually heated by a water-bath, by which the heat may easily be regulated and accidents from over-heating prevented.

(4) The still should never be filled more than two-thirds full of the liquid to be distilled, since otherwise it is liable to foam and boil over. Foaming may be avoided by covering the pan with a piece of coarse, wet cloth, permitting its edges to rest on the flange and when compressed making a vapor-tight joint.

For full description of apparatus employed in distillation see Remington's or Parrish's Practice.

*Sublimation is the process of distillation applied to solid substances, or, more correctly, the process whereby vapor is condensed to a solid.*

Substances easily volatilized, such as camphor, are separated from less volatile substances and obtained from their crude state or refined by *sublimation*. The product is said to have been *sublimed* and it is sometimes called a *sublimate* (*corrosive sublimate*), or *flowers* (*sulphur*).

Inorganic substances, such as iodine, sulphur, mercury, etc., are obtained in a pure form by sublimation. Mixtures of different substances or chemical compounds may often be separated by means of sublimation.

Dry or *Destructive* Distillation differs from ordinary distillation in that it is a process involving chemical changes for the production of gases, liquids, or solids from solid substance, such as wood and coal.

# Effects of Heat.

## FUSION.

When the state of aggregation in substances is changed from solid to liquid by the absorption of heat, the liquefaction is termed *fusion* or *melting*.

The *melting* or *fusing point* of a substance is the temperature at which it changes from the solid to the liquid condition. The fusing point is very different for different substances, some liquefying at a very low, others at a very high temperature; and others still, like carbon, resist the highest temperature we are able to command. These are said to be *infusible*.

The temperature at which fusion commences is constant for any substance so long as the pressure remains constant; and from the time that fusion commences the temperature remains stationary until the whole of the substance is melted.

Some substances, as iron and wax, soften gradually before they actually fuse, while others, as lead and copper, melt without softening. In the case of iron, great advantage is taken of this property, as by means of it the blacksmith can weld different pieces together, or mould them into any desired shape.

In the melting of fats, wax, resin, and similar easily fusible substances liable to injury by heat, this law has a practical bearing, viz., that no injury by exposure of the substance to heat can result until the fusion or liquefaction is complete.

Thus, in melting a substance from which a Cerate is composed, the vessel may be exposed to considerable heat without injury to the substance, so long as any portion remains unmelted. As soon as fusion is completed, however, the heat must be carefully regulated (or its source removed), since the temperature will now steadily rise if heat be applied.

The kind of vessels used in the process of fusion depends upon the chemical nature of the substance to be melted, and the degree of heat necessary for its liquefaction. For higher temperatures *crucibles* are employed.

In *pharmacy* the process of fusion is mostly applied to the production of Cerates, Ointments, Plasters and similar preparations composed of substances requiring a temperature usually below  $100^{\circ}\text{C}.$  ( $212^{\circ}\text{F}.$ ).

The *melting point* of a substance, similarly to the *specific gravity* and *boiling point* of liquids, is one of the characteristics whereby the

identity, etc., may be disclosed, and is therefore often referred to in the U. S. Ph. (Refer to the melting points of Wax, etc.)

The melting point of *fats* is determined by immersing a small portion of the substance in a test-tube of boiling water, in which a thermometer is placed, until completely melted. It is then allowed to cool, and the degree of temperature at which the substance commences to congeal, as indicated by the thermometer, is the *melting point*.

*Deliquescence* is the property which certain inorganic substances have to absorb moisture from the air and gradually pass into the liquid condition.

Potassium carbonate is an example of a substance which possesses this property in a high degree. Substances of this kind should be carefully protected from the atmosphere in well-covered cans or tightly-stoppered bottles, and, if possible, in a cool, dry place.

The term *hygroscopic* is applied to solids which attract moisture, but which, owing to their inferior solubility, do not pass into the liquid condition. Examples of this kind occur in many powdered extracts.

Among the important effects of heat are its *chemical effects*.

Heat causes a vibratory motion of the molecules of a compound substance. When the temperature is increased this motion may at last become so great as to cause the constituent elements to move out of the spheres of their atomic attractions, and thus cause decomposition of the substance.

Heat is one of the most useful agents for bringing about decomposition. Being a repellent force, and the repellent power increasing as the temperature rises, it is probable that if we could command a sufficiently high temperature even the most stable compounds would be separated into their elements.

The principal chemical effects of heat are the following:

*Calcination*, which consists in driving off volatile matter, in the form of gas, from solid substances by heat. The residue is usually left in the form of a friable powder, which is said to be *calcined*.

Calcination is used chiefly to expel Carbon Dioxide from its compounds (the carbonates). For example, when Calcium and Magnesium Carbonates are strongly heated, carbon dioxide and water escape into the atmosphere, and Lime and Magnesia, respectively, are left behind.

Sublimation may be regarded as the reverse of calcination, being, as already observed, a process for separating a volatile solid substance from one not volatile, and differs from it in that the volatile portion is the product desired.

*Ignition* is a term applied to the method of testing chemical substances by heating them to redness according to Pharmacopeial requirements.

*Deflagration* is a process seldom employed in pharmacy. It consists in heating one inorganic substance with another capable of

yielding Oxygen, resulting in decomposition and the formation of a new compound.

*Oxidation* is the union of substances with Oxygen producing *oxides*. This process is usually favored by heat, moisture and division of the substance, as in the formation of *rust* from iron, copper, etc.

Some elements: Phosphorus, Potassium, Sodium, etc., combine with Oxygen at the ordinary temperature; other substances, as Charcoal, require a very high heat.

*Reduction* is the process whereby Oxides or Compounds containing Oxygen are deprived of their oxygen by chemical action or the use of heat. The heating of metallic oxides, such as Red Oxide of Mercury, or the "roasting" of ores to obtain their metals, are examples.

The different stages of chemical effects of heat on *organic* substances are dependent upon the degree of heat, or combustion, to which the substances are subjected.

Thus, heating a vegetable substance, it at first becomes *roasted*; by increasing the heat it *chars* or "coals," if air is excluded, and finally by elevated temperature and in contact with air it "burns."

The following are the principal of these processes:

*Torrefaction*, or "Roasting," consists in scorching or parching organic substances to change or modify certain constituents without impairing the principles of the most value in the substance so treated.

The roasting of Coffee is a familiar example, in which the undesirable constituents are so modified as to give aroma to the berry without deterioration of the active principles, caffeine and caffetannic acid.

*Carbonization* is the process of reducing to coal by heating organic substances until all volatile matter is expelled, air being excluded. The substance is said to be "charred."

*Incineration*, or "Burning," is the union of oxygen with the elements of an organic substance by the application of heat, resulting in the production of flame and residue, termed *ash*.

## Desiccation.

The process of vaporization conducted as an operation of evaporation applied to solid organic substance is termed *Desiccation*. When applied to solid inorganic substances it is called *Exsiccation*.

Crude substances obtained from the vegetable and animal kingdoms are usually dried, or *desiccated*, before they can be utilized in medicine—as their bulk is by this means reduced, they are more easily preserved and their comminution is greatly facilitated.

As is well known, all organic matter contains water, which, at a favorable temperature, from  $32^{\circ}$  to  $49^{\circ}\text{C}$ . ( $90^{\circ}$  to  $120^{\circ}\text{F}$ .), facilitates changes in the principles usually present, resulting in decomposition of the substance, and frequently impairing its value.

Albumen, gum, sugar, starch, etc., are substances found in vegetable drugs, which, with moisture and exposure to warm temperatures, undergo putrefactive or fermentative changes. The presence of moisture and vegetable acids similarly causes the formation of fungoid growth (mold), which is detrimental to the substance, frequently diminishing its active principles, and hence impairing its medicinal value.

In depriving the substance of its moisture, by evaporation of the water, we therefore remove the principal cause of decomposition, *i. e.*, water. This process is termed *drying*.

While the most favorable temperature for decomposition is  $38^{\circ}\text{C}$ . ( $100^{\circ}\text{F}$ .), albumen coagulates at  $49^{\circ}\text{C}$ . ( $120^{\circ}\text{F}$ .) and at  $60^{\circ}\text{C}$ . ( $140^{\circ}\text{F}$ .) and above, most of the principles promoting change in organic substances become so modified by the heat as to permit no deterioration of the drugs, which are then designated as *cured*.

Since a temperature above  $32^{\circ}\text{C}$ . ( $90^{\circ}\text{F}$ .) cannot usually be obtained in temperate climates from the sun's rays alone, the drying of the drugs is generally effected by *artificial* heat, such as hot air or steam. Substances, previous to being dried, are, in the case of fleshy roots or bulbs, sliced; barks are deprived of the outer cork, fruits freed from the rind, etc., while leaves, seeds and flowers are generally dried whole. The procedure is generally very simple, and consists in exposing the substance properly prepared in shallow trays to hot air, or barks may be dried in a barrel, having a net at both ends, and placed upright, so that a draft of hot air may pass through the contents.

On a large scale, *drying-rooms* are used, heated by hot air or steam and

furnished with large shelves upon which the trays containing the substance to be dried are placed. It is necessary to admit fresh air in such drying closets at the bottom and provide an exit at the top for the escape of the air, which has become saturated with the moisture of the drugs in the form of vapor (see illustration). Unless so arranged that a current of air transverses the drying-room, acting as a carrying agent of the water, the evaporation will cease as soon as the air confined in the chamber becomes saturated with vapor.

The drying of chemicals, effected in the same manner, is to drive off the water of crystallization, whereby the crystals lose their shape, fall into a friable powder and the salt loses considerable weight. Such salts are termed *exsiccated*. (Example: Sodii Carbonas Exsiccatus.)

When Salts lose their water of crystallization by spontaneous evaporation they are said to *Effloresce*. *Efflorescence* is the opposite of *Deliquesce*.

As in the evaporation of liquids, the vaporization is facilitated by the extent of surface exposed by the substance to the source of heat and to the medium which serves to carry off the vapor—the air.

The *rate* of evaporation, therefore, is governed greatly by the following circumstances:

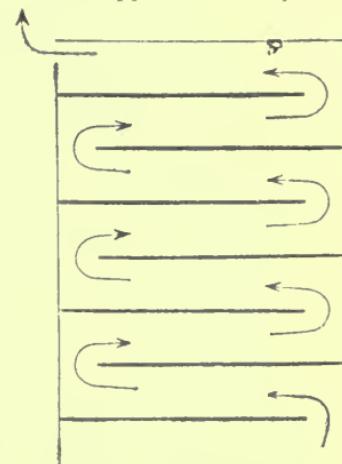
(1) The percentage of moisture in the air, and the rapidity with which the air in contact with the substance is removed.

(2) The state of division of the substance, or physical condition, and its affinity for water.

Thus, compact drugs, such as Aloes, Guarana, and Opium, must be exposed to heat for a longer period than porous drugs, *i. e.*, hop and senna.

The *degree* of temperature at which vegetable drugs are dried, varies with the character of the drug. While the maximum heat considered safe,  $60^{\circ}\text{C}$ . ( $140^{\circ}\text{F}$ .), may be applied to most roots, *i. e.*, Taraxacum, Inula, Senega, Gentian, etc., a temperature of  $49^{\circ}\text{C}$ . ( $120^{\circ}\text{F}$ .) should not be exceeded for herbs containing delicate principles, such as Belladonna, Hyoscyamus, Digitalis, etc.

Parts of plants containing aromatic, or other volatile constituents, such as the different Mints, Wild-cherry bark, and the various gum-resins, Asafoetida, Myrrh, etc., should be dried very carefully, lest their active principles should escape, thus rendering the drug more or less inert. Substances of the class named are frequently dried spontaneously by exposure to a warm atmosphere.



SHELVES IN DRYING CLOSET,  
With Direction of Hot Air Currents.

It is quite as important that the temperature at which the drug is dried be not so high as to volatilize any fugitive principle—in other words, that it be *properly* dried—as that the substance shall contain no moisture, that is, be *thoroughly* dried.

The quantity of water or moisture in some vegetable substances, when fresh, is quite considerable. Thus, certain leaves lose eight-ninths of their weight in being dried; fleshy roots and bulbs nearly as much; barks and similar parts of plants of close structure much less. Since, however, drugs are rarely used in the fresh state, this loss is immaterial, although it is readily seen that such drugs, carefully dried, must be correspondingly stronger than the same drugs containing this quantity of water.

#### PRESERVATION.

The preservation of vegetable drugs is highly important, and deserves more attention than it usually receives. The more fleshy parts of plants, for instance, roots of Rhubarb, Jalap, Colchicum, Columbo, etc., as found in pharmacies, are frequently worthless. This condition is generally due either to the fact that the root was not properly dried or “cured” when purchased, or that it had commenced to deteriorate when procured from the dealer.

To remedy this condition, the pharmacist should select only whole drugs of choice quality, and if, upon examination, they should prove to be imperfectly dried, steps should be taken at once to effectually free them from moisture by a proper application of heat. This can be readily accomplished by improvising a simple arrangement as outlined before.

Specimens of drugs of excellent quality frequently deteriorate for no other reason than that they are not perfectly dry; Rhubarb, and nearly all fleshy roots, easily become worm-eaten when in this moist condition, especially if stored in a damp place, where, owing to their hygroscopic qualities, they rapidly absorb moisture from the atmosphere. All vegetable drugs, especially when of this nature, must be protected from damp air. Barks, flowers and leaves do not, as a rule, deteriorate rapidly, though seeds and fruits undergo changes even when carefully preserved, and thus necessitate replenishment of stock annually.

#### GARBLING.

Vegetable substances should always be carefully examined for the detection of possible adulterations, either *intentional* or *accidental*. This operation is termed *garbling*, and substances so treated as *garbled*.

The most common form of *accidental* admixture in parts of plants, such as roots and leaves, is portions of the stems, which, being usually woody and inert, detract from the quality of the drug, and should invariably be *rejected*.

Cimicifuga, Leptandra, Ipecac and Gelsemium are specimens which in the whole or crude state are frequently mixed with considerable quantities of inert stem.

Dirt, especially *earth* adhering to the fibers, is met with generally in Hydrastis, Lepstrandra and Valerian. These drugs should always be procured, when possible, "washed."

Leaves are frequently accompanied by the stems, from which they must be separated, unless the stems possess medicinal properties and are recognized as the official part. Withered specimens, however, are practically inert and should be rejected.

Flowers are clean and easily preserved parts of plants; this is true also of Barks, which must, however, be gathered at the proper season and be free from inert cork and tough fiber.

Sometimes the admixture is *intentional*, when it is more difficult to detect it, since specimens possessing nearly similar physical properties, and similar also in appearance, are used for adulteration.

The most striking illustration of this is in Taraxacum, large quantities of which are frequently found to consist entirely of Chicory (*Cichorium intybus*); also in the substitution of German for English Valerian, which latter possesses greater medicinal strength, and is therefore more highly prized.

More attention should be paid by pharmacists to the *quality* of drugs, since adulteration and even sophistication can be detected in crude substances usually without much labor.

Adulteration in its usual forms of admixture, dirt and inert portions of plants, must be avoided to obtain preparations that are permanent and possess definite medicinal activity. The presence of earthy impurities in a vegetable drug detracts from the elegant appearance and permanency of the preparations made from it. *Inert* and *sophisticated* specimens are of course objectionable, because their use impairs the strength of the preparation.

Unfortunately, crude drugs are not procured in a form which admits of ready examination, since they are generally put up for the market in *pressed* packages. Large specimens of these drugs must be crushed before they can be pressed, and this renders their identification exceedingly difficult.

*Herbs* and *Leaves*, when procured in small packages, should be examined by opening one or more of these in each large package, so that the quality may be noted. Preference should always be given to drugs in *bulk*, since they admit of ready examination, give better satisfaction and are more economical to use.

## Comminution.

Crude organic substances as a rule require reduction to small or fine particles for pharmacal purposes. This process is termed *Comminution* (from *con* and *minuo*, Lat., to lessen), and embraces the following operations: Slicing, Cutting, Grating and Rasping, chiefly employed as preparatory to operations more effectual in reducing substances to finer particles.

*Contusion* is the operation of "Bruising" drugs in a fresh, or moist, state by pounding or beating them in a mortar.

### GRINDING AND POWDERING.

Grinding is the most common operation of the process of comminution. It is effected in *mills* and produces various degrees of fineness.

The vegetable substances used in medicine may be generalized from the standpoint of comminution—the process of reducing to small particles—into *fibrous*, *cellular*, *stony*, *horny* (*flexible*) and *fragile* or *conchooidal*.

*Fibrous* drugs embrace most of the roots and barks.

Roots of fibrous texture, such as Glycyrrhiza, Stillingia, Sarsaparilla, etc., should be cut transversely into pieces of about half an inch long and dried until crisp, when they can easily be reduced to coarse powder in an iron mortar or in a drug-mill. Barks may be treated in the same manner.

*Cellular* drugs comprise chiefly herbs, flowers and leaves.

These parts of the plant are generally very light and of loose texture, it being almost impossible to reduce them to a uniform coarse powder. Owing to the slight resistance they present, their reduction in a mill is very difficult, the mortar being best adapted for this purpose.

Small quantities of these drugs, to be used in the preparation of tinctures, etc., are reduced to a moderately coarse powder (*contused*) by first moistening the drug with the menstruum and then beating it in a bright iron mortar.

*Stony* drugs comprise only a few tubers, Aconite and Jalap and some roots, among which Stone root (*Collinsonia*) and Gelsemium are conspicuous.

These drugs rarely appear in the market whole, since they can only be reduced to powder in mills worked by steam-power. Some of these drugs possess poisonous properties, and great care is therefore necessary in grinding them.

*Horny* or *Flexible* drugs include mostly seeds and low forms of organization, such as Ergot and Galls.

These drugs are very difficult to powder; owing to their flexible nature, they pass between the grinding plates of a mill, unless it be a powerful one, intact. The best work can be effected by pounding them in a large iron mortar, the constant concussion having the best effect upon the shell of the seed. *Nux Vomica* is especially difficult to reduce to powder, but when steamed for a few hours and then dried, it may be powdered with comparative ease.

By *Fragile* drugs is meant such as break readily and present a conchoidal fracture. They embrace most of the gums, resins and natural extracts, such as *Acacia*, *Guaiac* and *Aloes* respectively.

These are easily and quickly reduced to powder in a large Wedgewood mortar with a flat bottom. This class of drugs usually requires drying, as they contain a large percentage of water.

#### POWDERING.

All substances are more readily acted upon by solvents when reduced to *powder*, for the reason that in this form the *greatest surface* is presented to the solvent action of the liquid.

Vegetable drugs consisting of parts of plants are composed of cellular tissue in which the active principles are found. The medicinal constituents, alkaloids, neutral principles, resins or acids, are in solution in the sap flowing through the cells which make up the tissue, and, upon evaporation of the water in the process of drying, are left in these cells in a more or less soluble condition. When, therefore, it is desired to obtain these principles in solution, it is necessary to rupture the cell-walls, so that the solvent action of the liquid used in the extraction (menstruum) may exercise its full power.

It is obvious, therefore, that the *degree* of fineness of a powder of any given drug should be, as far as practicable, proportioned to the size of the cells which make up its structure.

In vegetable drugs the cell-walls are usually a sort of septum or membrane which permits solution of the principles they contain by the entrance and outflow of the liquid charged with the constituents of the drug. This phenomenon is termed *osmosis*, or, when applied to the separation of different substances, *dialysis*. With the aid of this property, peculiar to most organic substances, solution of the constituents of a plant may often be effected without reducing the part to a fineness corresponding to the size of the cells. This is the case whenever the active principles are soluble in water. It so happens, however, that the cell-walls do not acquire the power of osmosis until they have been restored to the condition they had previous to drying, or, in other words, until they have absorbed *water* to saturation.

On the other hand, the active principles of a great many drugs, especially alkaloids, resins and oleo-resins, are scarcely soluble in water, and such menstrua must be used for extraction (alcohol) as will readily dissolve them,

water being therefore excluded. It is necessary with this class of substances to reduce them to *very fine* powder for extraction, since only the solvent action of the liquid can be relied upon, the exhaustion of the drug not being favored by *osmosis* through the cell-walls.

A general rule is, therefore: When *alcohol*, or *strongly alcoholic* menstrua, are used, the drug to be extracted must be in *very fine* powder to admit of complete exhaustion.

For this reason, Cinchona, Aconite, Belladonna, Nux Vomica, etc., are directed to be in *very fine* powder.

On the other hand, with drugs the active principles of which consist of acids, *i. e.*, Senna, Gentian, Taraxacum, or other similar principles soluble in water, the fineness need not be greater than that of a *moderately coarse powder*; the water permeating the cell-walls and inducing the osmotic action, exhaustion will soon be completed.

*Gum, pectin and sugar* are inert substances frequently present in drugs, and since they are rendered more or less soluble by water or watery menstrua, they may retard extraction if the drug be in a *very fine* powder.

#### MORTARS.

This well-known piece of apparatus, the first invention of aboriginal man for the purpose of reducing vegetable substances to a condition suitable for food, is indispensable in the pharmacy and has long been the accepted symbol of the art and the profession.

Mortars are made of wood, stone and marble for contusing; of brass and iron for contusing and powdering, and of porcelain and glass for triturating.

The *Wedgwood* mortar, so named after the inventor of a kind of earthenware made in England, is the most durable and suitable of any.

In its various shapes and sizes it answers the purposes of all the operations of powdering, trituration and mixing, but not that of contusion, since it is very hard and easily fractured by a hard blow of the pestle.

In the pharmacy some drugs may be powdered in an iron mortar placed upon a stand fixed in the ground, and provided with a spring to the pestle firmly fastened to the rafter of the ceiling. A cord attached to the small end of the spring and fastened to the pestle handle permits the pestle to descend by the force of the hand.

Cinchona, Ergot, Opium, etc., may be powdered by means of this inexpensive and labor-saving device. Squills, gums and gum-resins when chilled may be reduced to *very fine* powder without difficulty; it is necessary, however, in order to preserve them in the powdered form and prevent "caking," to add a small quantity of some inert matter, such as milk-sugar. This class of powders must be stored in tightly-stoppered bottles, and in a cool, dry place.

## Trituration.

Trituration (from *tritus*, Lat., to wear) is the operation of reducing a substance to the finest state of division by grinding the particles together for a long time.

While in a pharmacal sense a *powder* may mean any degree of fineness, in a popular sense a "powder" means the highest attainable degree of fineness. To such is often also applied the term "pulverized" (from *pulver*, Lat., powder).

The finest state of division of solid substances is designated in pharmacy as *impalpability* and such fineness as *impalpable*. An impalpable powder is defined as a powder of such fineness that *its particles are not sensible to the touch*.

The powdered Drugs and chemicals of commerce are usually of this degree of fineness, obtained by trituration.

The reduction of vegetable substances to this degree of fineness is generally conducted on a large scale, since it requires expensive machinery and steam power.

The *dusting process* is that usually employed, and consists in crushing the drug by means of stones of large diameter and great weight, revolving on a base; the dust which rises during the process accumulates upon the platform placed at a height of about four feet, and is collected. Such mills are termed "chasers."

Drugs which present a *conchoidal* fracture, and are more brittle, are easily powdered on a small scale in a ball-mill, or "pot-mill," which consists of a hollow ball of any desired dimensions, revolving upon an axis. In the interior of this hollow ball are placed two or more cannon balls (through a convenient opening which may be closed with a large flat cork). The weight and triturating action of the cannon balls reduce the substance quickly to a very fine powder.

Chemical substances are easily triturated in a mortar to a very fine powder. Active medicines, such as Calomel, and Alkaloids and active principles, are triturated with other substances, such as Milk Sugar, to insure more complete division and enhance their medicinal action. (See Triturations U. S. Ph.)

*Levigation* is the operation whereby a substance is reduced to the finest particles by triturating it with a *liquid*. It may be performed either in a mortar or on a slab with a muller. The trituration of metallic oxides with oils in the preparation of ointments, as in Ung. *Hydrargyri Oxidi Rubri*, is a good example.

## SIFTING.

The operation of separating the *coarse* from the *fine* particles of a substance, which has been ground or powdered, is termed *sifting*.

It consists of passing the substance through a *sieve*, made of cloth of different sized meshes corresponding to the various degrees of fineness desired. These cloths are of iron and brass wire for the coarse and fine powders and of hair and silk, or bolting-cloth, for the finest, or impalpable powders.

For the purposes of extraction it is necessary to have the drugs of a *uniform fineness*, and this is obtained by passing them through sieves of a certain number of meshes to the linear inch.

These *degrees* of fineness are directed by the U. S. Ph., '90, as follows:

A <i>very fine</i> powder . . . . .	No. 80 powder.
A <i>fine</i> powder . . . . .	No. 60 powder.
A <i>moderately fine</i> powder . . . . .	No. 50 powder.
A <i>moderately coarse</i> powder . . . . .	No. 40 powder.
A <i>coarse</i> powder . . . . .	No. 20 powder.

*Elutriation* is the operation of separating the finer particles of a substance by suspending the powdered substance in water—decanting the *lighter* portion freed from the heavier *coarse* particles and obtaining them in a fine condition by subsidence and evaporation of the water.

This operation has been termed “water-sifting”. It depends for its action upon the adhesion of the smaller particles to the water-molecules. Prepared Chalk is a well-known example of a substance “prepared” by this method in a form free from grit.

## Solution.

When a solid is transformed into the liquid state, by heat, it may be said to undergo the process of liquefaction, but when a substance (solid or liquid) is rendered into permanent liquid form by distributing its particles throughout the liquid it is said to *pass into solution*.

Solution as a pharmacal operation, therefore, is the mechanical *separation* and *diffusion* of the molecules of a *solid* substance through a *liquid*.

For example, when a small quantity of common salt is placed in water, it gradually disappears from view, the water becomes saline to the taste, and its specific gravity is increased. This liquid mixture of salt and water is called a *solution*. The liquid in which the solution takes place is called a *solvent*.

In all cases of solution proper, neither the solvent nor the dissolved solid undergoes chemical change. The solid retains all its original properties except solidity, and may, by evaporation of the solvent, be recovered from the liquid in the original form, without loss of weight. Such solutions are called, for convenience, *simple* solutions.

Solution is often accompanied by chemical combination, that is, the solid not only disappears in the liquid, but at the same time undergoes chemical change, or enters into combination with the liquid.

The resulting liquid is, for convenience, called a *chemical* solution, or a *complex* solution, but it must be borne in mind that the two processes of solution and chemical combination are radically different in their nature, and only such facts pertaining to the latter as will aid in distinguishing between these two kinds of solutions are considered in this Lecture.

Solution is purely a phenomenon of molecular attraction. The particles of the solid are pulled asunder and diffused through the liquid by virtue of the attraction exerted upon them by the molecules of the liquid. In chemical combination, on the other hand, a new force comes into play, that of chemical affinity, which changes the identity of the substances and builds up new compounds out of the old.

For example, if a small quantity of Iodine be added to an aqueous solution of Potassium Hydrate (caustic potash) and the mixture be heated, the Iodine will gradually disappear, but it will be found, on examination, that something more than solution has taken place. On evaporating the liquid, no Iodine, as such, will be found, the Potas-

sium Hydrate will have disappeared, and Potassium Iodide and Iodate, entirely new substances, will be found in the residue.

Another difference between these important processes is their effect on temperature.

A *lowering* of the temperature always results from solution, while chemical combination invariably produces the *opposite* effect.

In the case of many anhydrous substances, as Lime and Caustic Alkalies and Alcohol and Sulphuric Acid, their solution in water produces an elevation of the temperature. This apparent exception to the law is due to the fact that they combine chemically with a portion of the water and such solutions should, therefore, be strictly regarded as chemical solutions.

In the case of a mixture where both solution and chemical combination take place, it is evident that the opposite effects of these two processes on the temperature will tend to neutralize each other.

The solution of many salts causes so great a reduction of temperature, that advantage is taken of it to produce *freezing mixtures*, as when Common Salt is mixed with Snow a temperature more than forty degrees below the freezing point is attained.

Another difference between solution and chemical combination is the fact that the latter takes place most easily between substances which are most *unlike*, while solution usually takes place most readily between substances that most *resemble* each other in composition and properties.

Thus Acids and Alkalies form chemical combination and solution, while Fats form simple solution with Ether and Resins with Alcohol.

As solution is one of the most important agencies in the hands of the pharmacist for performing many operations, it is important for him to understand the conditions most favorable to the operation.

As a great general rule, whatever *weakens* the cohesion of the particles of a substance promotes solution.

The means used to weaken cohesion are chiefly three in number:

(1) Heat, (2) Mechanical division and (3) Favorable position of the substance as regards the solvent.

*Heat* weakens cohesion, because it increases the spaces between the molecules, and also because it increases molecular motion.

A hot solvent is usually more speedy in its action, and takes up a larger quantity of the solid substance than a cold one. But the law has some notable exceptions. Common salt, for example, is no more

soluble in hot than in cold water, and Lime is far less soluble in the former than in the latter.

The *Mechanica division* of a substance is accomplished in various ways: by agitation, by grinding, as in a drug-mill, and by trituration, as in a mortar. It not only weakens cohesion, but by reducing the substance to a fine powder exposes a vastly greater surface to the action of the solvent.

When weak solutions of readily soluble substances are to be made, the method of agitation is usually to be preferred; that is, the substance is dropped into a suitable vessel, and the mixture shaken until solution is complete. Where strong solutions are required, or where the substance is not readily soluble, solution is facilitated by trituration with a solvent in a porcelain mortar. The substance is first rubbed to a powder, a little of the solvent is then added, and the rubbing continued until the liquid is saturated or nearly so, when this portion is poured off in the same way. This process is continued until all of the substance has been dissolved.

The importance of a favorable position of the substance with reference to the solvent, is shown in the method of *circulatory displacement*.

The substance to be dissolved is suspended just beneath the surface of the liquid, on a porous diaphragm, or in a bag of some porous material. The liquid in contact with the substance dissolves a portion of it, has its specific gravity increased in consequence, and therefore sinks to the bottom of the vessel, and a fresh portion of the solvent is brought in contact with the substance. Currents are thus established in the liquid, the effect of which is to keep that portion of it, which is farthest from saturation, and has most solvent power, in contact with the substance to be dissolved.

Many substances are so readily soluble that either heat or division effect their solution so rapidly as to retard the process. This is for the reason that the liquid becomes quickly saturated and of such thick consistency (viscid) as to envelope the solid particles and prevent access of fresh solvent.

Sugar dissolves more rapidly in coarse powder (granulated) than in fine powder and Gum Arabic forms a solution with cold water more quickly than when heated.

#### SOLUBILITY.

Different solids differ from each other very widely in solubility. A few are insoluble, many slightly soluble, and many freely soluble.

Some, like Gum Acacia, are soluble in all proportions, and some,

like Potassium Chlorate and Calcium Sulphate, only in limited proportions. Some that are insoluble or nearly so in pure water, become freely soluble in certain saline solutions, as for instance, Benzoic and Salicylic Acids, that dissolve but sparingly in pure water, are dissolved in large quantities by solutions of Alkaline Acetates, Carbonates and Phosphates in water, but this cannot be regarded as strictly simple solution. The reverse is usually the case, however, as, for instance, an aqueous solution of Sugar will dissolve less of a salt than pure water.

Sustances that are sparingly soluble in one liquid may be freely soluble in another, as Camphor, which is taken up only in small proportion by Water, but is dissolved in very large quantity by Alcohol and Sulphur, which resists the action of all ordinary solvents, but melts away like sugar in water, when agitated with Carbon Disulphide.

The quantity of a solid which a solvent will take up must be determined by experiment in each case, as there is no known law governing *solvent action*.

The solubility of most substances varies regularly with the temperature until a certain limit is reached, beyond which no further increase takes place; but in some cases solubility increases faster than the temperature, and in others it increases to a certain point with heat, and then declines. As in the case of liquids, the Specific Gravity and Boiling Point and in some solids the Melting Point, are regarded as important characteristics, and reference is made thereto in the U. S. Ph., so is the solubility of a solid indicated by the *number of parts of the different liquids required to effect complete solution of one part of the solid*.

Since the solubility is influenced by temperature, solubilities are always referred to the uniform temperature of 15°C. (59°F.).

The most common Solvents are: Distilled Water, Alcohol, Ether, Chloroform, Benzin, Carbon Disulphide and the Fixed and Volatile Oils of which latter Oil of Turpentine is the type.

A solvent is said to be *saturated* when it refuses to take up more of a given solid. The term is also used in a chemical sense. For instance, an acid is said to be saturated with an alkali when the solution is neutral to test paper.

[Refer to Solubilities of the principal officinal chemicals in the U. S. Ph.]

A solvent is said to be *supersaturated* when it contains in solution

more of a solid than it would take up if the solid were treated with the solvent at the given temperature.

For example, if we prepare a saturated solution of Sodium Sulphate in a test-tube, and stop the test-tube while the liquid is still boiling and allow the solution to cool, without agitation, to the temperature of the air, it may be kept for weeks or months without crystallizing; but if a glass rod be plunged into it, crystals will suddenly be formed through the entire mass.

The phenomenon is accounted for by supposing that the molecules, being held in equilibrium by their mutual attractions, are not free to obey the polar forces that produce crystallization until a disturbing cause is introduced.

The term supersaturated is also used in an entirely different sense by chemists. An acid, for instance, is said to be supersaturated by an alkali when more than enough of the latter has been added than is sufficient to neutralize the former.

*Diffusion* of one liquid through another is of the same nature as solution, and, like it, is a phenomenon of *molecular attraction*.

Liquids differ from each other very widely in their power to diffuse through water. Some, as the Fixed Oils, do not mingle with Water at all; others, like the Volatile Oils, are sparingly dissolved by it, and still others, as Glycerin and Alcohol, mingle with it in any proportion.

#### OSMOSIS.

The mingling of liquids or gases by diffusion through animal or vegetable tissue capable of being wet by both liquids, is called *osmosis*.

Such membranes possess multitudes of excessively minute pores which constitute so many capillary tubes, by means of which the liquids are brought in contact with each other and enabled to commingle. This phenomenon is due to *capillarity*, a result of molecular attraction.

When the process of osmosis is applied to the separation of the crystallizable from uncrystallizable substances, it is termed *Dialysis*.

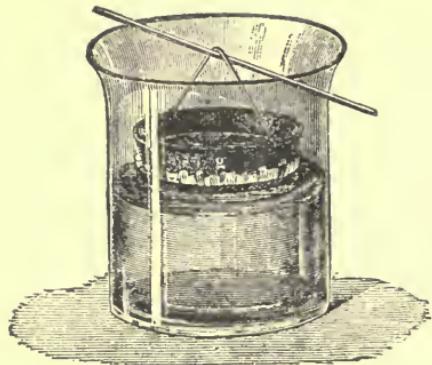
The strength of the currents passing in opposite directions through the membrane depends partly on the densities of the liquids and partly on their power to wet the membrane. Other things being equal, the strongest current is toward the denser liquid; and if the liquids are of equal density the stronger current will be toward the liquid that has the least power to wet the membrane.

Crystalloids diffuse readily through porous membranes, colloids do

not; hence it becomes possible by osmosis to separate the latter from the former, by *dialysis*.

A *Dialyzer* consists of two vessels, one suspended in the other. The outer vessel contains the liquid in which it is desired to obtain the diffusible portions, distilled water being mostly used for this purpose. The inner vessel, or the dialyzer proper, consists of a ring

of India-rubber or glass, to which a piece of parchment paper is securely fastened, as in a drum, at the bottom. The liquid to be dialyzed is poured into the last mentioned vessel, which is then suspended in the water so that the bottom barely reaches below the surface of the water. In pharmacy this process is used in the preparation of Dialyzed Iron and some Alkaloids.



THE DIALYZER.

chemical change, usually causes no change of temperature.

The diffusion of gases through liquids is called *absorption*.

This is also a phenomenon of molecular attraction, and does not differ in its essential nature from solution. Its effects on temperature, however, are often different from those of solution. In cases where large quantities of a gas are absorbed by the liquid, the temperature rises, because the absorbed gas is condensed in volume, and a portion of its latent heat is thereby rendered sensible. Also an *elevation* of temperature usually facilitates solution, while a *lowering* of temperature increases the absorption of a gas. Pressure has the same effect. This is illustrated in charging a Soda Fountain with Carbon Dioxide.

## Filtration.

Filtration is the process of removing *undissolved* matter from a liquid; the clear liquid thus obtained is termed the *filtrate*.

When the operation is applied to viscid substances, such as syrups, oils, etc., or to remove grosser impurities, it is termed *straining*.

Filtration, in pharmacy, is usually applied to solutions in which the substance dissolved has been thrown out of solution—precipitated, from a change in temperature or other cause. The operation is always effected mechanically by passing the liquid containing the undissolved matter through some material of sufficiently close texture to arrest the solid particles, while the clear liquid is allowed to flow through freely. Such material is termed a *filtering medium* (plural, *media*).

The most common Filtering Media are: Paper, Cotton, Sand, Glass-wool and porous Earthenware, the form of the auxiliary apparatus employed, except in the case of the last mentioned, being a *funnel*.

The nature of the filtering medium used depends upon the *mobility* of the liquid and the character of the undissolved matter. With watery, alcoholic, ethereal and similarly mobile liquids, when not too concentrated, filter paper is commonly used.

*Filter-paper* is of two kinds, *gray* and *white*, in circular and square sheets respectively.

*Gray* filter-paper is the kind employed in pharmacy; it is made of woolen rags, and is therefore coarser and more porous than the white, or so-called Swedish filter-paper, used in analytical operations. The gray filter-paper is stronger, can bear the weight of a large quantity of liquid, filters more rapidly, and is therefore to be preferred when large quantities of galenical preparations, *i. e.*, tinctures, medicated waters, etc., are to be filtered.

The *rapidity* of filtration is of great importance, both for expediting work and to prevent loss by evaporation which cannot always be overcome even though the vessel used in the operation be well covered.

Filtration is favored, other things being equal, by the following considerations:

(1) The filter should be carefully folded. The *folding* of a filter, or “plaiting,” is accomplished in various ways, but no filter can be considered perfect unless folded to resemble a fan with 32 exactly equal parts, with the edges perfectly even when laid together (as in a fan).

and narrowing down to as small a point as possible, without breaking the paper. The result is easily accomplished in a very simple manner, as follows:

The sheet of round filter-paper is to be folded into 32 equal parts, the folds passing through the center. The sheet is first folded into halves by laying its circular edges evenly together and making a sharp crease along the fold with the thumb-nail or a spatula, then into quarters by folding at 16.

For better illustration (see figure), we shall now number the different parts of the double sheet according to the 32 parts the circle represents, each successive *fold* being designated by its respective number.

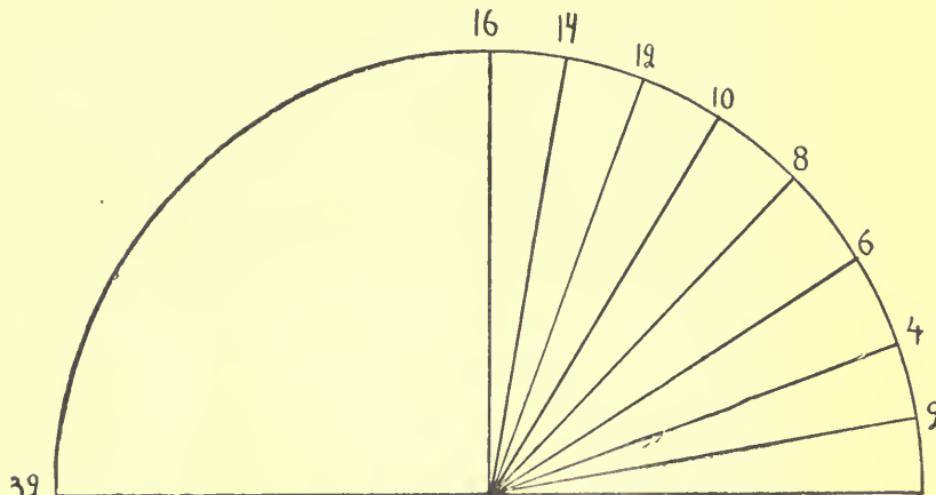


DIAGRAM OF FILTER HALF FOLDED, THE LINES CORRESPONDING TO THE RESPECTIVE FOLDS.

The first fold is made at 8; it is then opened out and folded *forward* at 4; then *backward* at 2, and again *backward* at 6.

Each fold should be made perfectly straight and as close to the point as practicable without rupturing the paper.

The folded parts 2, 4, 6, and 8 are then gathered up to 16 and folded at 12, then folded *backward* at 10, then *forward* at 16 and *backward* again at 14, which completes the folding of the 16 parts or one-half of the circle or filter.

The other half is folded in precisely the same way.

(2) The filter should be pushed down into the neck of the funnel as far as possible without rupturing the paper.

This is especially desirable when syrupy liquids are to be filtered, such as elixirs and similar liquids which filter slowly. For this purpose a funnel with a wide neck should be employed (see Funnels); the point of the filter paper is by this means strengthened, and the crevices formed in the paper, when pushed down into the comparatively narrow neck of the funnel, facilitates filtration, and aids in rendering the filtrate clear.

This fact is taken advantage of in the arts in the filtration of syrups, oils,

etc., through bags made of filtering cloth in the following manner: A long bag, narrow at the top and gradually widening at the bottom, is forced into a narrow tin cylinder so that the sides of the bag are filled with fissures and furrows; the upper end of the bag is securely fastened to an opening in the lid of the tin cylinder, which is screwed on air-tight. The liquid to be filtered is permitted to flow through this opening into the bag; the insoluble matter which it holds in suspension lodges upon the protruding sides of the confined bag *gradually*, not in such quantity as to prevent the outflow of the clear liquid, which would be the case if a bag with straight sides were employed.

Filtration is usually further facilitated, in this and other kinds of filters, by allowing the liquid to flow through a tube, which is connected air-tight with the filter, from a height of 10 to 30 feet; this is termed filtration by *pressure*.

(3) The filter should be thoroughly moistened before filtration is commenced.

In filtering liquids which readily mix with water, this is very important. The fiber of filter-paper, owing to its porosity when dry, absorbs considerable water by capillary attraction; in filtering watery solutions, therefore, the solid which was held in solution is left more or less undissolved in the pores by the attraction of the water, thus preventing the penetration of the liquid. With saturated solutions this is so marked that in some cases they may be poured upon a paper filter, not previously moistened, without any of the liquid passing through; such examples we have in syrups.

The filter, accurately plaited, is opened out completely and then pushed into the neck of the funnel, as before described; by gently pressing the top with the flat hand, while held there firmly to prevent its slipping up, a small stream of water is sent into the funnel by means of a wash-bottle or "spritz." When the paper has become in the least moist, it will adhere to the glass without danger of slipping, and the hand must be removed, since the least pressure will rupture the paper. The funnel is now gently turned by the hand so that the thin stream of water may be evenly distributed, then set aside for a few minutes to allow the superfluous water to drain off, when it is ready for use.

During the operation of filtration, the following points should be observed: (1) Provision must be made for the air to *escape* from the receiving bottle; (2) the filter should be replenished with the liquid so as to be *completely* filled as long as the quantity permits, and (3) the funnel should be kept *covered*.

The air is usually allowed to escape by placing a loop of twine in the neck of the receiving bottle. Funnels, ribbed on the outside, are also used with this object in view, but these do not answer the purpose as well as the twine, for the reason that glass, when pressed into the neck of a bottle, becomes frequently wedged in so tightly as to break when its removal is attempted.

The more liquid in the filter, the *greater* the *pressure*, and there

fore the more *rapid* the filtration; hardening of the undissolved matter, and consequent stopping up of the pores of the paper, may be prevented by having the filter as *full* of the liquid as possible.

The funnel should always be kept well *covered*, to prevent evaporation; this is best effected by the use of pieces of rubber packing, which fit closely on the edge of the funnel; pieces of glass or cardboard may also be used.

The filter-paper must never extend *above* the top of the funnel.

The plaited filter, previous to being moistened, should be inserted in the funnel and measured as to length; if it extends beyond the rim, it should be cut off evenly, so as to reach rather half an inch below than above the top. This is done partly to facilitate covering the funnel, which cannot otherwise be effectually done, but more especially to prevent *evaporation*, which sometimes takes place so

rapidly, when the filter extends considerably beyond the funnel, as to carry some of the liquid down the outside. An illustration of this phenomenon, due to *capillarity*, is shown in the accompanying figure.

*White* filter-paper is rarely used in pharmacy; it is well adapted for the analytical laboratory and for filtering acids and alkaline solutions where the gray would be objectionable, because of its

#### CAPILLARY ATTRACTION.

colors and impurities being soluble in chemical reagents.

Its principal use in pharmacy is in filtering solutions containing precipitates, which latter it is desired to obtain pure by washing with water. For this purpose a funnel resembling an equilateral triangle is most convenient, since the precipitate is more exposed upon the sides than in the ordinary funnel for pharmacal use. This filter-paper is also folded in quarters, and simply dropped into the funnel to adjust itself by the weight of the contents, so that all portions of the precipitate may be washed by the water poured upon it. This filter-paper may be "toughened" so that it will bear the weight of acids and alkalies by immersing it in strong nitric acid (sp. gr. 1.40), and then washing with water. Paper treated similarly with sulphuric acid becomes also very strong, but is not easily permeated by liquids. This is the substance known as *parchment*.

Various devices are in use for facilitating filtration, such as *filter-*



racks, made of wire, also *supports*, consisting of a china cone with openings in the sides, to be placed inside the funnel, etc. These do not insure such rapid filtration as by the simple funnel with attention to the above rules.

*Continuous filtration* is employed when larger quantities are to be filtered, and when the filter is of limited capacity.

It may be effected by inverting the bottle containing the liquid over the funnel through an opening in the cover, which admits the neck below the top of the filter, as shown in the illustration. By this arrangement the filter is kept filled with liquid up to the level of the neck of the inverted bottle as long as any liquid remains in the receiver, the liquid acting as a valve, by excluding the air from the latter. As soon as the liquid in the filter sinks below the neck of the container, air rushes in and displaces it until the level is again reached, thus working automatically. The splashing by the outrushing air may in a great measure be prevented by inserting a perforated cork in the neck of the container, so that the displacement will take place more gradually.

*Filtration in vacuo* is accomplished by exhausting the air from the receiving vessel with an air-pump. It is chiefly employed in the chemical laboratory in filtering viscid alkaline solutions, or such liquids as act upon the filter-paper, causing it to retard their flow. A small perforated cap of platinum is placed in the neck of the funnel to prevent the point of the filter from breaking by the suction created. The *mercury pump* is the means employed in small operations for producing a vacuum; in the arts pumps worked by steam power are used.

The *filtration of oils* is effected either in the cold, or through heated filters.

In the cold, oils require to be filtered through substances more porous than paper, *i. e.*, cotton, flannel, etc. Few oils (fixed) can be filtered when cold, especially the vegetable oils, cottonseed, castor oil, etc., since they contain a large percentage of gum. By gently heating them, however, by the water-bath filter, they may be filtered without difficulty; but care must be taken that the filtration does not take place at too high a temperature, lest they become cloudy again upon cooling.

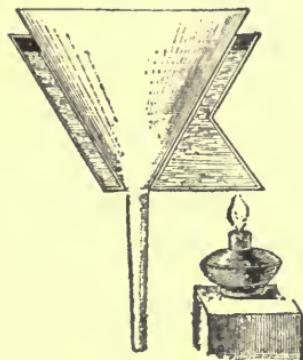
*Hot or water-bath filters* are constructed in different ways, the most common form being an ordinary funnel placed in a double or jacketed cone of tinned iron filled with water, and furnished with a projecting tube which is heated by a spirit-lamp.



CONTINUOUS FILTRATION.

*Filtering media*, other than those mentioned, are:

*Absorbent Cotton*, for neutral mobile liquids. This is especially useful for filtering small quantities of liquids. A small pledget is pressed into the neck of the funnel and held in place with a glass-rod while the liquid is poured in.



WAFER-BATH FUNNEL.

#### STRAINING.

Straining differs from filtration mainly in that more porous media are used for filtering the liquids than filter-paper.

This operation is usually applied to more viscid liquids or mixtures to free them from gross impurities, as, for example, in the making of syrups.

The materials most frequently used for straining are: Canton Flannel, Felt-bags, Cotton, Unbleached Muslin and Calico.

For small quantities, flannel, or a plug of absorbent cotton, placed tightly in the neck of a funnel, are the most convenient.

For large operations, as in making the syrups by the gallon, a felt bag is the most convenient and satisfactory means, since the whole amount of liquid may be poured in at once and returned to the bag until it runs clear.

The *tenacle*, consisting of four pieces of wood joined together so as to form a square, and furnished in each corner with a projection upon which the filter is fastened, is a convenient device for suspending the bag or filter cloths above the receiving vessel. It may be supported by a stand, or suspended from the ceiling by a hook.

In *straining syrups*, it is even more important that the strainer be thoroughly moistened with *water* than in filtration through paper.

When a felt bag is used it should be soaked in water until completely saturated, then wrung out or pressed as hard as possible to free it from superfluous water. When the liquid to be strained is poured in, it displaces the water, which first comes through almost pure, and should be returned

*Sand* is sometimes a very useful filtering medium, and is especially adapted in connection with alternate layers of charcoal for filtering large quantities of water. *Pumice-stone* powder is frequently mixed with gummy or resinous substances to facilitate the passage of liquid solvents.

*Sponge* is used for straining, but does not present any advantage, since it is difficult to clean perfectly and too costly to reject when once used.

*Chamois skin* is sometimes used as a filter-cloth when pressure is applied. Owing to its great strength it is not liable to rupture.

to the filter. Since a considerable portion of the liquid remains in the pores of the filter at the close of the process, it should be also displaced by the addition of sufficient water to make up the measure, but the product should then be carefully mixed so as to be of uniform composition.

#### CLARIFICATION.

When a liquid contains insoluble matter suspended in so finely divided a form that it cannot be separated by simple filtration, some other *insoluble* substance is added to which the insoluble matter is attracted, or the chemical character of the liquid is changed so that it may be obtained clear—*clarified*.

Clarification may be either *pharmacal* or *chemical*.

When clarification is effected by pharmacal means, or filtration, the insoluble substances used form a layer over the filter, which retards the insoluble matter but does not impede the flow of the liquid.

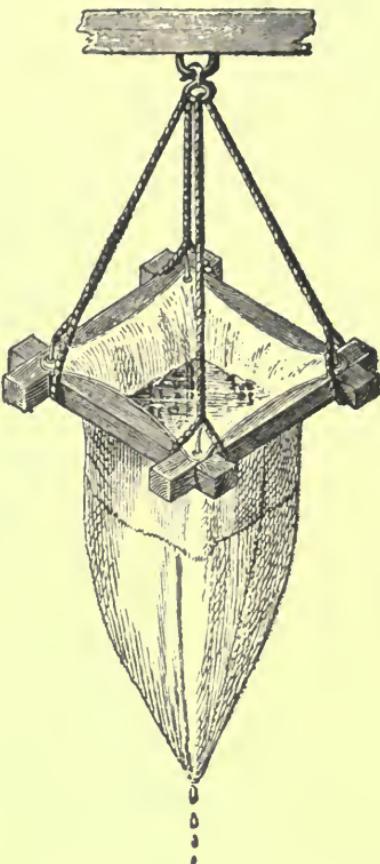
The substances used for this purpose in order of their merits are:

(1) *Paper pulp*, prepared by beating in a bright iron-mortar a sheet of gray filter-paper, moistened with sufficient water to make a pasty mass.

After pressing out the water, the pulp is added to the liquid and thoroughly mixed by agitation. In commencing filtration the first portions of the filtrate must be returned to the filter until the pulp has formed a layer over the sides, after which the product is obtained clear. Paper pulp is especially useful in filtering elixirs and straining syrups.

(2) *Insoluble chemical substances*, such as Calcium Phosphate, and Talcum; also Magnesium Carbonate.

Since substances used for clarification must be insoluble in the liquid, that they may not contaminate the filtrate, Magnesium Carbonate is objectionable owing to its slight solubility in water, especially if the latter be acid. For this reason it has been superseded in the U. S. Ph. by Calcium Phosphate, which is nearly insoluble in neutral liquids.



FELT-BAG STRAINER WITH  
TENACLE.

The *Chemical* methods of clarification are:

(1) The use of Albumen in the form of egg-white which effects clarification by chemical means through combining with the soluble matter and forming insoluble compounds, which are usually thrown to the bottom of the liquid—*precipitated*.

By the application of heat albumen coagulates, envelops the insoluble particles and makes the liquid clear, as in the clarification of "coffee" by the addition of egg-white.

*Gelatin* forms a very insoluble compound with tannic acid, as, for example, in the preparation of leather; and as the insoluble substances which we desire to reject by clarification are mostly tannic acid derivatives, its value for this purpose is clearly recognized and it is extensively employed in the form of Isinglass for the clarification of Beer.

(2) Another method employed for the purpose of clarification is the process of *Fermentation*.

Some liquids, as the expressed juices of Fruits, often contain insoluble matter in so finely suspended condition as to make its removal by mechanical means impossible. By permitting such liquids to undergo fermentation, the sugar, through which the particles are kept in suspension, is converted into alcohol, in which the suspended matter is also insoluble and therefore is precipitated and easily removed. The clarification of apple-juice and grape-juice in the making of Cider and Wine respectively, are good examples.

#### DECOLORATION.

When it is desired to free a liquid from color, it is easily effected by filtration through some absorbent substance, such as charcoal. The operation is called *Decoloration*, or "Decolorization."

It is purely a *physical* process designed to remove the coloring principle through the capillary attraction of the agent employed.

*Animal Charcoal*, the agent usually selected, is a mass of minute pores to which many substances in solution are attracted and by them retained.

The liquid is permitted to flow through a layer of the Charcoal in coarse powder, or granulated, placed upon some porous media in a funnel. Alternate layers of Sand and Charcoal are very effective in decolorizing and purifying water, and also to free it from organic impurities, which the charcoal absorbs.

Distinction must be made between decoloration as a form of Filtration and the term frequently but erroneously employed to designate a substance deprived of color by chemical reaction.

*Funnels* used in filtration should be of *glass*, in order that the operation may be watched; also because they are easily cleaned, and not acted upon by chemicals.

The *shape* of a funnel for filtering purposes should be that of a V

rather than one so wide at the top as the glass funnels generally found in the shops; one having an angle of 45 degrees will filter much more rapidly than one of 90 degrees.

This is explained by the fact that the column of the liquid is thereby heightened and the pressure increased in proportion to the height of the liquid.

On the other hand, the tube portion of the funnel should be as wide as possible; gradually sloping for a distance of several inches, or in proportion to the size of the funnel, about one-third the length of the tube. The end of the tube, or, as it is sometimes called, the "neck" of the funnel, should not be too thick, as is frequently the case, since this prevents inserting the funnel in the neck of bottles, but should be of a thickness uniform with that of the glass in the other part of the funnel.

The *wash-bottle*, or "spritz" is a very useful adjunct in pharmaceutical work for washing precipitates, wetting filters, and for introducing small quantities of water in test-tubes, etc. It consists of a rather wide-mouthed bottle furnished with a perforated cork, into which two bent glass tubes are introduced, one reaching down into the liquid and a shorter one ending just above the surface. By blowing in the short tube, the air, pressing upon the surface of the liquid, causes it to rise in the long tube, and to flow out at the contracted end in a fine stream with considerable force.



WASH-BOTTLE.

# Crystallization.

Many substances, under certain conditions, particularly when passing from a fluid to a solid state, arrange themselves in *regular geometric forms*. Such forms are called *Crystals* (from *Krystaino*, Gr., freeze, congeal) and the process is termed *crystallization*.

Substances which crystallize are termed *crystallizable*, while those that do not, as shellac, glue and glass, are called *amorphous*. In assuming the crystalline form bodies tend to reject foreign matter, and crystallization is therefore an important process in the purification of many substances.

When the regular external form of crystals is wanting, but present in the interior, the body is said to have a *crystalline structure*. Small irregular forms are called *crystalline powder*.

The science descriptive of crystals, called *crystallography*, treats of the various forms of crystals. It needs but a brief reference in these Lectures.

The *form* of a crystal depends upon its planes or *faces*. The point of union of two faces is called an *edge*; of more than two faces, an *angle*. The forms of crystals are determined by imaginary lines drawn vertically to the faces or from opposite angles, to intersect each other in a common central point and form angles corresponding to the boundary angles. These lines indicate the directions in which the molecules arrange themselves, according, as it is supposed, to the *polar force* and they are termed the *axes* of the crystal.

According to the *number* of these axes, their relative *lengths* and the *angles* at which the lines intersect in the crystal, there are six different systems of crystallization as follows:

1. The *Isometric* or Regular, having three axes of equal length intersecting at right angles.
2. *Tetragonal*, Rhombic, or Quadratic, having two axes of equal and one of unequal length intersecting at right angles.
3. *Ortho-Rombic*, or Trimetric, having three axes of unequal length, intersecting at right angles.
4. *Monoclinic*, or oblique Prismatic, having three axes of unequal lengths, two obliquely inclined to each other, intersected at right angles by a third.

5. *Triclinic*, or Doubly oblique, having three axes of unequal length, all obliquely inclined to each other.

6. *Hexagonal*, or Rombohedric, having one axis of unequal length intersecting three of unequal length at right angles.

The following terms are commonly employed to designate shapes of crystals:

*Prismatic*, shaped like a prism.

*Tabular*, with a flat (table) top.

*Laminar*, in thin plates or scales (flakes).

*Acicular*, needle-shaped.

When a substance crystallizes according to more than one system it is said to be *di-*, *tri-*, or *poly-morphous* as it assumes two, three, or several forms respectively.

*Isomorphous* is the term given to such substances as crystallize in the same form.

Many substances, in the process of crystallization, combine with a certain amount of water, which is called *water of crystallization*. This water is usually present in definite proportions and is so given in the Molecular Formula of chemicals, as, for example,  $\text{FeSO}_4 + 7\text{H}_2\text{O}$ , means that Ferrous Sulphate of the U. S. Ph. contains 7 molecules of water of crystallization.

When such substances are deprived of their water of crystallization they are said to be *exsiccated*, or dried (*Ferri Sulphas Exsiccatus*).

When the water is simply enclosed mechanically in the crystals, as in Potassium Nitrate, it is called *interstitial water*.

Crystals may be formed in a variety of ways:

(1) By *sublimation*.—Such substances as Iodine, Camphor, Sulphur, Calomel, Corrosive Sublimate, Ammonium Chloride and Carbonate may by this means be freed from foreign materials.

(2) By *fusion*.—Many substances, as Sulphur, the metals Bismuth and Antimony, and some salts, assume the crystalline form on cooling from fusion. This method has few important applications in pharmacy. Of much greater importance is the next method.

(3) By *cooling* from solution, or by *evaporation* of the solvent. In the former case a saturated solution of the substance is made in an evaporating dish or other shallow vessel, at an elevated temperature, and the solution is allowed to stand until cold. After the crystals have been deposited the mother liquid is drained off.

Usually not all of the substance crystallizes out at the first trial; the mother liquid should therefore be concentrated by heat and again allowed to cool, and the process repeated so long as crystals continue to form.

In case large and well-formed crystals are desired, the solution should not be too strongly concentrated at first, and the crystals should be permitted to form slowly, and if the nature of the liquid will admit, by *spontaneous evaporation* of the solvent.

In case crystals are required in the form of fine granules, the solution should be concentrated until crystals begin to form around the edges of the dish, and then the solution should be cooled rapidly and stirred during the cooling. In many cases the application of heat may be continued until the solvent is evaporated, keeping up in the meantime the stirring. This method is called *granulation*.

Where the solvent is a highly volatile substance like ether, benzol or carbon disulphide, a cold saturated solution is made, and the solvent allowed to evaporate spontaneously. By dissolving Sulphur in carbon disulphide fine crystals of the former substance may be obtained by this method.

(4) By *addition* of a substance to a solution of a crystallizable body, whereby the solvent power of the liquid is diminished and the dissolved matter is thrown out in the form of crystals.

This may be effected in two different ways: The addition of a soluble solid having affinity for the liquid, which, passing into solution, produces a supersaturated solution, thus throwing the original dissolved matter out of solution which serves as a *nucleus* for the formation of crystals. For example, Glucose, in watery solution, does not crystallize, but upon the addition of a crystal of *anhydrous* Glucose it at once forms a crystalline mass, if the solution be concentrated.

It may also be effected by a change in the character of the solvent, as by the addition of Alcoholic liquids, Tinctures, etc., to saturated solutions of Sugar, in the *precipitation* of Salts in aqueous solution by the addition of Alcohol, etc.

(5) By *Chemical Reaction* in a solution by which an *insoluble* or *less soluble* substance is formed, which appears as a crystalline *precipitate*.

#### PRECIPITATION.

Precipitation as a chemical process is the operation whereby an *insoluble* compound is formed from mixing the solutions of two or more *soluble* compounds. The product is termed a *precipitate*.

In a chemical sense, precipitation is always the result of a chemical *decomposition*, new compounds being formed. Since the result depends upon the *insolubility* of the newly-formed compounds, this process can only be employed where the product is known to be *insoluble*.

For example, when two soluble salts, Potassium Iodide and Lead Acetate, are dissolved separately, and their solutions mixed, a chemical change takes place, due to an interchange of the elementary constituents of the substances, and new compounds are formed—Lead Iodide, which, being insoluble in water, is precipitated, and Potassium Acetate, which is soluble and remains in solution in the water.

The term *precipitation* is also applied to any substance which is thrown out of a solution from a liquid, as, for example, precipitates in Tinctures.

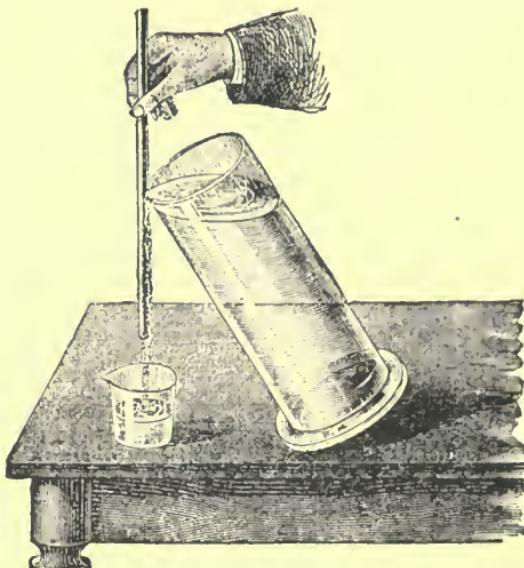
The compound in solution is separated either by *decantation*, when heavy or crystalline, or by *filtration*, when flocculent or gelatinous.

When a precipitate is desired in a pure form it is necessary to *wash* and *dry* it. The precipitated matter is washed by transferring it to a filter, and after having been drained, small portions of liquid, usually distilled water, is poured upon it. After having again been drained it is dried, either in a drying-oven or by simple exposure to the air.

*Decantation* is the simplest method for the separation of Liquids. It is effected by pouring the liquid into a tall and narrow vessel and after subsidence of the heavier, or insoluble portion, the clear liquor is poured off.

In pouring from such vessels, especially when not furnished with a lip, it is necessary to use a guiding rod, as shown in the illustration to prevent the liquid from running down the outside.

Other methods of separating liquids are by means of the *Syphon*, which depends for its action upon the quantity of the liquid in the longer and lower end of the tube, and the *Pipette* and *Burette*, glass-tubes with bulbs, which are also used for the accurate measurement of liquids.



POURING WITH GLASS-ROD.

# Extraction.

Extraction is the process by which the soluble matter of organic drugs is obtained or separated from the insoluble portion. When extraction is completely effected the drug is said to be *exhausted*.

Extraction may be effected by either of the following operations:

- (1) Maceration, Expression and Filtration.
- (2) Maceration with heat, Expression and Straining.
- (3) Maceration and Percolation.

*Maceration* consists in mixing the drug, reduced to a coarse powder, with the liquid used for extraction (the menstruum), and allowing the mixture to stand for some time (from 1 to 36 hours, according to the proportion of the menstruum used and the nature of the drug).

When the soluble matter of the drug has become dissolved in the menstruum, it is obtained as a clear liquid free from the insoluble portion, the *marc*, by expression.

*Expression* is the operation of straining through a suitable cloth with pressure exerted either by hand or by a *screw-press*.

The most effective way of expressing by hand is to fold together the edges of the press-cloth so that one overlaps the other (as in wrapping a paper package) the ends being meanwhile gathered up so as to prevent the mixture running out. These ends are then twisted in opposite directions, care being taken that the middle fold does not give way.

The custom of adding a portion of menstruum to the marc (drug) after expressing it, is not to be recommended, unless necessary to make up the measure of the product. It is preferable to use as much more menstruum originally as will be retained by the marc, which can easily be approximated by experience and observation.

In extracting a drug by simple maceration the temperature should be moderately *warm*, as the solvent action on the drug is then greater.

In extraction by any form of maceration, with or without heat, the drug must be in a *coarse* powder.

When in fine powder the small particles of drug rapidly swell and adhere to each other as soon as they come in contact with the liquid, and thus prevent the solvent action of the menstruum. The expression of the liquid is also more difficult when fine powder has been used, since the fine portions clog the pores of the press-cloth.

When a drug is macerated in hot water for a short time, by pouring boiling water upon it in a well-covered vessel, the liquid obtained by

expression, upon the cooling of the mixture, is termed an *Infusion*. The U. S. Ph. gives a general process for the Infusions.

Drugs containing volatile principles, *i. e.*, Chamomile, Valerian, etc., are frequently prescribed in this form. The boiling water extracts these principles, and if a proper vessel be used, such as the "Infusion Mug," which can be tightly covered, the water will gradually condense, retaining the fugitive constituents. Infusion from drugs whose active principles are volatilized by heat, are prepared by simple maceration in the *cold*, *i. e.*, *In fusum Pruni Virginianae*.

*Digestion* is maceration in conjunction with heat. When a moderate heat is applied to facilitate extraction in connection with maceration the process is termed digestion.

When the mixture is boiled for some time the liquid product obtained by expression is termed a *Decoction*. For these a general process is given in the U. S. Ph.

#### PERCOLATION.

As extraction is the most common of pharmacal processes so is *percolation* the most important related operation, since it is the most effective, economical and expeditious method for the extraction of the medicinal principles of drugs.

The process of *Percolation* as directed in the U. S. Ph., '90, consists in subjecting a substance, or a mixture of substances in powder, contained in a vessel called a Percolator, to the solvent action of successive portions of a certain menstruum, in such a manner that the liquid, as it traverses the powder in its descent to the receiver, shall be charged with the soluble portion of it and pass from the percolator free from insoluble matter, this product being termed the *Percolate*.

This process is also called *displacement*, because it is based upon the principle that the solvent, after being charged with the soluble constituents of the drug, is *displaced* by fresh portions of the solvent liquid; partly from its own weight, partly from the pressure of the supernatant liquid; it continues to be displaced until the process is interrupted.

By continuing the supply of solvent, which is termed *menstruum* (plural, *menstrua*) when used in extraction, the displacement of the liquid in which the soluble matter is in solution may be effected until no more is to be dissolved from the drug, when it is said to be *exhausted*.

The exhaustion of a drug is generally determined by the absence of color and taste of the percolate.

With resinous drugs it may be conveniently determined by mixing a few drops of the percolate with water; if exhausted, the percolate will not turn the water milky. In percolating drugs containing alkaloids, complete exhaustion has been effected when the percolate does not show any precipitation with reagents for alkaloids.

This is called *simple* percolation, and is the process usually followed in the preparation of tinctures, wherein the quantity of menstruum is largely in excess of the drug to be exhausted.

When employed, however, for more concentrated preparations, viz., Fluid Extracts, where the volume of the product must correspond with the quantity of drug used in the extraction *measure for weight*, it is necessary to concentrate the percolate. The first three-fourths portion of percolate contains nearly a corresponding proportion of the principles of the drug, while the remaining one-fourth of the soluble matter requires usually a much greater amount of menstruum before it can be displaced. The three-fourths portion of the percolate is, therefore, *reserved*, and extraction continued until the exhaustion is complete; the percolate thus obtained, being very dilute or *weak*, is concentrated to the required bulk, with the application of the least possible amount of heat, and then mixed with the reserved percolate. (See Preliminary Notices—Percolation U. S. Ph., '90, p. xl-xlii.)

*Fractional* or *re-percolation*, introduced by Dr. E. R. Squibb, is a process by which the drug may be exhausted *volume for weight*, without entailing evaporation.

It differs from simple percolation in that the drug is divided into four portions, and packed in as many different percolators; each portion is treated as in simple percolation, except that the weak percolate obtained from each is used to moisten and extract each *succeeding* portion, the first percolate being reserved and mixed finally with the percolate from the last percolator, when their *combined volume* corresponds to the weight of the drug.

*Simultaneous fractional percolation* is a modification of the process of re-percolation recommended by C. S. Hallberg, differing in that the entire quantity of the drug may be moistened *at once*, packed into four percolators and the process completed in a much shorter time.

To conduct percolation successfully, the following points must be observed:

- (1) Appropriateness of the apparatus.
- (2) Degree of fineness of the powdered drug.
- (3) Care in the moistening and the packing.
- (4) The use of proper menstrua.

The *Apparatus* employed in percolation is simply a vessel to contain the drug, a receiving bottle, and sometimes a tube to carry the percolate into the receiver without loss by evaporation, and to regulate the flow.

Formerly glass Funnels were much used for percolation. While these answer fairly well when the product is not desired too concentrated as in the extraction for Tinctures, they have been superseded quite generally of late by percolators.

A *Percolator* is a funnel with more or less cylindrical rather than

conical sides, which are deeper proportionately than those of a funnel. The outlet tube, or "neck," is shorter and made thicker than in a funnel. They are made of glass, tinned iron, earthenware and wood.

*Glass* percolators are to be preferred, because in packing the drug the operator is enabled to see the material from the outside, and thus obtain better results; also because the percolation can be observed in its various stages, and proper means taken to render it more effective if necessary. The rate of extraction and exhaustion, when completed, may easily be recognized, also when the menstrua has sunk below the surface of the drug, the necessity of replenishing will be at once noticed.

*Tin* percolators, though largely used, are in most instances objectionable, not only because they are lacking in the advantages of glass, which alone should be sufficient to condemn their use, but also in that the material from which they are made is usually acted upon by drugs. When drugs containing acids, *i. e.*, Cinchona, Rhubarb, etc., are percolated in tin percolators, the reaction is so great as to contaminate the percolate, which may be detected by a darker coloration (due to the presence of tannate of iron) than in products where glass vessels have been employed. In tin percolators the soldering seam is seldom air-tight, resulting in evaporation and loss, both of alcohol and percolate and as found in the market, they are rarely correctly constructed as to shape or dimensions.

*Wood* and *earthenware* percolators are largely used in manufacturing, where glass would be too fragile or too expensive, for percolating drugs which would affect metal, or when chemical menstrua are used.

A *Pressure Percolator* is fitted with an air-tight cover through which the menstruum is supplied to the drug by a tube, connected with a reservoir containing the menstrua. The reservoir being placed high above the percolator, the liquid is forced through the drug by *hydrostatic pressure*. The Anderson and the Suit's are the best.

Percolators suitable for pharmacopœial quantities should be nearly *cylindrical* or slightly *conical*. The neck should be short and become gradually narrow at the opening in the percolator so as readily to admit the insertion of a cork with a glass-tube. Fitted to the tube is a piece of rubber-tubing, about one-fourth longer than the percolator itself. This is attached to the body of the percolator by a rubber band.

By raising the tube to the level of the liquid in the percolator, the flow is interrupted. By lowering the tube the flow may be regulated to be either *fast* or *slow*. For the receiver, any bottle will answer, but a graduated wide-mouthed bottle is the best. In the absence of a graduated "etched" bottle, one may easily be improvised by placing a narrow strip of cloth adhesive plaster lengthwise upon the bottle, measuring into it water by the cubic centimeter and then marking the strip carefully at the level of the water. A strip of paper pasted on the bottle may also be used, but it then requires a coat of varnish.

The *rate of flow* of the percolate for the pharmacopœial quantities should not exceed from *ten* to *thirty* drops per minute.

The proper *fineness* of drugs for percolation is very essential to the success of the process. If the drug is in too *coarse* a powder, exhaustion will not be complete; if too *fine* percolation may cease.

With most drugs, the degree of fineness of the powder suitable for percolation is directed by number (see Sifting, Lecture II) in the U. S. Ph.

In drugs not officially recognized, the number of powder used should be the same as that of an official drug containing similar constituents. [For the general law and principles governing the degree of fineness of drugs for extraction, see "Comminution," Lecture II.]

*Packing.*—A drug should always be *moistened* and allowed to macerate in order to *swell*, before packing it in the percolator.

The powdered drug, contained in a shallow dish, is uniformly sprinkled and then thoroughly mixed with sufficient menstruum to cause it to adhere in a mass when pressed in the hand, but not so wet that it will not readily break up and fall into a powder.

In *moistening* drugs containing a large proportion of soluble matter (*extractive*, gum, sugar, etc.) the powder agglutinates, especially if very fine, as in Cinchona and Rhubarb, forming small balls which cannot be rubbed to powder with the hands. Such moistened powder should be sifted through a coarse sieve, and the agglutinated particles rubbed through with the fleshy hand.

As a rule, the *more extractive* a drug contains, and the *more aqueous* the menstruum, the *more difficult* it is to moisten.

Conversely, the *less extractive* in the drug, and the *more alcoholic* the menstruum, the *easier* it is to moisten, and therefore the *less care* is required.

This is also true of *packing* the powder in the percolator. With the first-mentioned class great care must be taken that the powder be dropped successively in small quantities, and that the pressure in packing be not so great as to cause formation of compact layers of the drug, which could only be penetrated by the menstrua with great difficulty, if at all. On the other hand, with the latter class, containing less extractive and requiring alcoholic menstrua, such as Buchu, Cubeb, Ipecac, etc., the packing may be done much more quickly and with less care, since these powders are easily penetrated by the alcoholic menstrua.

In packing the powdered drug the following procedure should be observed:

First, prepare the percolator by inserting a piece of absorbent cotton (cut across the fiber to expose the pores) in the neck, and of such size that it covers the bottom of the percolator. Upon this a piece of filter paper, cut

round and "nicked," is carefully laid so as to extend a half-inch up the sides, being first moistened with the menstruum, and then a thin layer of fine sand. The first portion of powder is then carefully introduced to guard against any falling between the filtering media, distributed evenly, and gently pressed. With the second portion the pressure is somewhat increased and continued with each successive portion until all the powder is packed.

For packing, a cylindrical piece of wood, cut square at the end, is used. The powder is now covered with a disk of paper or cloth, upon which are placed a few pieces of glass or similar heavy material to keep it in place. The menstruum is then poured in, a sufficient quantity constantly being supplied to keep the surface of the powder covered until the percolate begins to flow at the end of the tube, when the percolator should be carefully covered and set aside, if maceration is directed or deemed necessary.

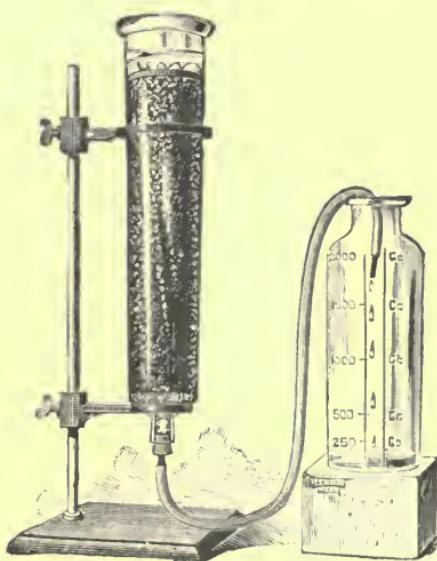
*Maceration.*—It is not necessary to continue maceration more than 24 hours with drugs containing little extractive, but with more extractive drugs, also such as contain alkaloids, extracted with difficulty, *i.e.*, Cinchona, Hyoscyamus, Nux Vomica, etc., the maceration may be prolonged for three or four days.

With this latter class it is always best to allow the powder to macerate for an hour or two before it is packed in the percolator, so as to permit it to "swell;" without this precaution, the drug is liable to swell when confined in the percolator, and thereby impede the flow of the menstruum.

The *menstruum* (plural, *menstrua*) or the liquid used for extraction, is usually Alcohol, or Alcohol diluted with Water in various proportions, sometimes with an addition of Glycerin. When the greater proportion is water, the menstruum is generally said to be *aqueous*; when Alcohol is the greater, it is termed an *alcoholic* menstruum.

*Chemical solvents* are sometimes employed for the more effective extraction of drugs whose principles are soluble with difficulty in *neutral* menstrua.

*Alkaline menstrua* are employed with resinous or acid drugs, such as Glycyrrhiza and Rhubarb, and *acid* menstrua, when the active principles consist of Alkaloids, as in Cinchona, Conium and Nux Vomica.



PERCOLATION.

The menstruum should be selected with reference to its *solvent* power and its adaptability to hold the extracted matter *permanently* in solution, or to prevent precipitation.

The *character* and *solubility* of the constituents of the drug must be known to insure the use of the best solvent.

As a general rule, therefore, alkaloidal, resinous and oleo-resinous drugs require *alcoholic* menstrua.

Acid and extractive drugs require *aqueous* menstrua. There are, however, some exceptions to this rule, and the menstrua directed in the U. S. Ph. should be used in all official preparations.

In some drugs the constituents vary greatly as regards solubility, since they contain at once oils, acids, and alkaloids, all possessing medicinal value.

In such cases it is difficult to select such menstrua as will extract all these constituents without their subsequent precipitation in the percolate.

*Glycerin* is here well adapted as a medium, since it possesses *intermediate* solvent properties between alcohol and water, as it dissolves to a great extent *all* the principles soluble in either alone. The use of glycerin should be confined to menstrua having only the above purpose in view.

The displacement of the menstrua with weak alcohol or water should not be attempted until the greater portion of the extract has been obtained. It is best to begin with a liquid slightly less alcoholic in strength, and then gradually increase the proportion of water until finished. With drugs containing considerable gum, starch, etc., liable to swell, great care must be taken, that water be not used too early in the process.

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## Inorganic Pharmacy.

This division comprises the *inorganic* substances, their Compounds and Preparations.

They will be treated with reference to their derivation and production, their purification and preparation, and their pharmaceutical and medicinal properties and uses.

The chemical theories and principles involved are not particularly treated here, but are reserved for the Lectures on Chemistry. Nevertheless, the various processes employed in the production and preparation of Chemical substances, the reactions involved and their physical and chemical characters and properties, are sufficiently explained to render the study comparatively easy. It is assumed that every student has a general knowledge of chemistry, however slight, and this should be extended by reference to some text-book on chemistry in conjunction with the study of these Lectures.

The following terms are used quite frequently and the respective distinctions should be carefully observed:

*Elements*, which include the *Gases*, such as Hydrogen; the *non-metals*, or metalloids, such as Iodine, Bromine; the *metals*, such as Iron, Copper, Lead; the *alkali metals*, Potassium, Sodium, and the *alkaline earths*, Calcium, Magnesium, etc.

A *Compound* is the product of two or more of these elements, which may be an *Acid*, a *Base* or a *Salt*.

A *Preparation* is the particular form given to an element or a compound by dissolving it or mixing it with a substance for certain uses. It differs from a compound in that while the latter is the product of different elements, possessing new and distinctive properties from the elements from which it was made, the substances that enter into a *preparation* do not lose their chemical properties, but are simply changed in form.

Thus Potassium Iodide is a *compound* of Iodine (and Potassium), but Tincture of Iodine is a *preparation* of Iodine; Sulphuric Acid is a *compound* of Sulphur, but Precipitated Sulphur is a *preparation*, or *form* of Sulphur.

The distinction is the same as that between a *compound*, or chemical, solution and a *simple* solution. In the former instance a chemical change takes place, in the latter a physical change only.

The preparations, being regarded more especially as pharmacal products, are mostly treated separately in a succeeding Lecture, according to their respective classes, i. e., Waters, Solutions, Spirits. There are some exceptions to this rule, and under each element and

compound the respective preparations are always enumerated and often completely described.

#### COMPOUNDS OF HYDROGEN AND OXYGEN.

*Water.*— $H_2O$ .—Aqua, U. S., natural water in its purest attainable state.

A colorless, limpid liquid without odor or taste at ordinary temperature and remaining odorless while being heated to boiling.

The U. S. Ph., prescribes that water should contain not more than 0.05% soluble salts, that it be free from metallic impurities and nitrites and fixes limits for the presence of sulphates, chlorides, nitrates and organic impurities.

Water may be purified by filtration through Animal Charcoal and Sand and by *precipitation* with Alum (Alum. et Potass Sulph.) or Ferric Chloride.

The following adjectives are used to designate different kinds of water, *pura*, pure; *fluvialis*, river; *pluvialis*, rain; *fontana*, fountain.

From water the following are prepared:

*Distilled Water.*—Aqua Destillata, U. S.—From 1,000 volumes of water the first 100 volumes are rejected and of the remainder 800 volumes are collected by distillation.

It should be preserved in loosely-stoppered containers.

*Medicated Waters*, Aqua Medicata.—The official class of waters; also:

*Hydrogen Dioxide Solution.*—Aqua Hydrogenii Dioxidii, U. S.—Solution of Hydrogen peroxide. A slightly acid, aqueous solution of Hydrogen Dioxide,  $H_2O_2$ , containing about 3 per cent of pure Dioxide corresponding to about 10 volumes of available oxygen.

Peroxide of Hydrogen is made by decomposing Barium Dioxide with Phosphoric Acid, freeing the solution from Barium Phosphate by precipitating it as insoluble Barium Sulphate with Sulphuric Acid.

*Properties and Uses.*—As a ready source of oxygen for bleaching and anti-septic purposes. It should be kept in loosely-stoppered bottles in a cool place to prevent the disengagement of the oxygen which may otherwise result in explosion.

# The Inorganic Acids.

Acids, whether *organic* or *inorganic*, except in the case of the so-called *haloid* acids, like Hydro-chloric Acid, are built on the type of the water-molecule, and consist of a negative Atom or a group united by Oxygen to Hydrogen. If we represent the water-molecule thus: H—O—H, an acid molecule would be represented thus: X—O—H, X representing the negative atom or group of atoms.

*Character and Properties.*—Acids are characterized by possessing a *sour* taste, by the property of changing certain vegetable *blues*, like blue litmus, to *red* and by the power they have of combining with *bases* to produce *salts*.

Some acids are *mono-basic*, that is, are built on the plan of one water-molecule, and have one replaceable hydrogen atom, as Nitric Acid, H—O—(NO<sub>2</sub>); others are *di-basic* and have two replaceable hydrogen atoms as Sulphuric Acid  $\text{H}-\overset{\text{O}}{\underset{\text{H}}{\text{O}}}-(\text{SO}_4)$ ; and some other acids have a still higher *basicity*.

In the inorganic acids the *number* of Hydrogen atoms in the formula indicates the *basicity* of the acid, but this is not always true of the organic acids, since one or more hydrogen atoms may enter into the constitution of the complex negative radical. Inorganic acids, or, as they are also called, "Mineral Acids," with but *one* Hydrogen atom can form but *one* series of Salts by combining with Bases, but those that have *two* or more Hydrogen atoms may form *two* or more series, according as all or only a part of the Hydrogen atoms are replaced by the basic Radical.

For example, Sulphuric Acid, H<sub>2</sub>SO<sub>4</sub>, may react upon Soda and produce, under different circumstances, two different salts. In case both its Hydrogen atoms are replaced by Sodium, neutral Sodium Sulphate Na<sub>2</sub>SO<sub>4</sub>, will be produced, but if only one of the Hydrogen atoms is replaced by the Sodium, Acid Sodium Sulphate HNaSO<sub>4</sub>, will be produced. The latter salt still possesses acid properties.

The *Haloid Acids* differ from the other in molecular plan by having the negative Radical directly united to Hydrogen without the mediation of an Oxygen atom, as Hydrochloric Acid, HCl, Hydrobromic Acid, HBr, and Hydriodic Acid, HI. These Acids form a corresponding series of Salts by uniting with Bases. Common salt, NaCl, is an illustration.

Some of the acids are solid, some liquid, and some gaseous at ordinary temperatures.

*Solid* Acids.—Arsenous, Boric, Chromic. Arsenous and Chromic Acids are not true acids; these will be considered with their respective elements. There are eight official Organic Acids that are solid and three that are liquid.

*Liquid* Acids.—Nitric, Nitrohydrochloric, Phosphoric, Hypophosphorous, and Sulphuric.

*Gaseous* Acids.—Hydrobromic, Hydrochloric (Hydriodic and Hydrofluoric not official), Sulphurous and Carbonic Acid and Hydrocyanic Acid which may be here included.

#### GENERAL PROPERTIES AND USES.

The chief inorganic acids occur commercially in three different forms, designated with reference to their strength and purity, viz:

“Com.,” Commercial, for industrial uses.

“U. S. P.,” Responding to the tests for purity and strength of the U. S. Ph., for medicinal and pharmacal purposes and

“C. P.,” Chemically pure, when a degree of purity higher than the U. S. Ph. degree is required for analytical tests and reactions.

The strengths of liquid acids are designated by the percentage by weight of real, or anhydrous acid, determined by the specific gravity and by the number of C.C. of the V. S. (volumetric solution) of Potassium Hydrate required to exactly neutralize a given number of C.C. of the acid. (Refer to U. S. Ph., Volumetric Solutions, p. 482.)

*Preservation and Handling.*—Especial care should be used in storing acids in a cool place, as they expand by heat, some volatilize and some are liable to freeze and expand through extreme cold (as Sulphuric Acid) and burst the container. They should always be kept in glass-stoppered containers and care must be observed in loosening the stopper should it become tightly fixed in the bottle.

*Pharmacal Uses.*—As chemical solvents and precipitants; for the extemporaneous preparation of their respective compounds; for corroding, etching and many other purposes in the arts and manufactures.

*Medicinal Uses and Antidotes.*—To counteract alkalinity in the system; to increase the action of alkaloids and to furnish refrigerant draughts, for which organic acids are, however, mostly used. The corrosive action of concentrated acids taken internally is counteracted by the administration of carbonates of calcium and magnesium, oil, soap and demulcent liquids.

# The Haloid Acids.

These include the acids of Bromine, Chlorine, Fluorine and Iodine.

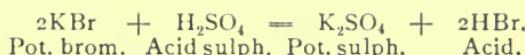
*Hydrobromic Acid*.—Acidum Hydrobromicum.—A haloid acid having the formula HBr.

*Preparation*.—It is made by causing Water to react on Phosphorus Bromide as expressed in the following equation:



The hydrobromic acid is separated from the phosphoric acid by distillation.

Also made by decomposition of Potassium Bromide with Sulphuric Acid, the Potassium Sulphate allowed to crystallize and the acid separated by distillation:



*Properties*.—A colorless gas, with a strong, irritating smell, and an acid taste and reaction. It liquifies only at the low temperature of  $-73^{\circ}\text{C}$ . and becomes a colorless solid at  $-87^{\circ}\text{C}$ . It fumes on exposure to the air, as also does its aqueous solution. Like hydrochloric acid, it has a strong affinity for water, and dissolves in it in very large proportion. It is the aqueous solution which is used in medicine, and to which the name, hydrobromic acid, is usually applied. The aqueous solution that contains 49.8 per cent of the acid gas has a sp. gr. of 1.515.

*Diluted Hydrobromic Acid*—Acidum Hydrobromicum Dilutum, U. S.—A liquid composed of 10 per cent by weight of absolute Hydrobromic Acid and 90 per cent water. Sp. gr. 1.077.

It is readily distinguished from hydrochloric acid by the addition of chlorine water, which sets free the bromine. It should be preserved in glass-stoppered bottles.

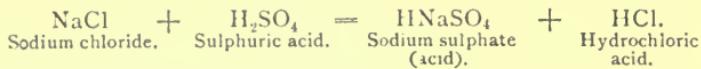
*Medicinal Uses*.—Chiefly administered in place of Bromides in doses from 1 to 4 C.C.

*Hydrochloric Acid*—HCl.—Acidum Hydrochloricum, U. S.—A liquid composed of 31.9 per cent by weight of absolute Hydrochloric Acid and 68.1 per cent of water. Sp. gr. 1.16.

This is also a haloid acid, and, like hydrobromic acid, absolute hydrochloric acid is gaseous at ordinary temperatures, and it is the aqueous solution that is used in the arts, and to which the name Hydrochloric, or "Muriatic," Acid is applied.

*Source*.—The pure acid gas is obtained by treating pure Common

Salt with pure Sulphuric Acid, according to the following equation:



and collecting the gas over mercury or by the displacement of air. The aqueous hydrochloric acid is obtained by passing the gas into water, the latter liquid absorbing it in large quantities.

*Character and Properties.*—The gaseous hydrochloric acid is intensely irritating to the air passages, and strongly acid in its chemical reaction. It is condensable to a liquid at a temperature  $-4^{\circ}\text{C}$ . and a pressure of 25 atmospheres. Its sp. gr., taking air as the standard, is 1.278.

The official Hydrochloric Acid is a colorless, fuming liquid, intensely acid to the taste and in its chemical behavior, and possesses a pungent suffocating odor. Heated with Manganese Dioxide it evolves Chlorine, and in a solution of Silver Nitrate it produces a curdy white precipitate, which on exposure to light soon turns purple.

*Uses.*—In the preparation of various official Chlorides; with nitric acid to form Nitro-Hydrochloric Acid; for generating Chlorine; and in promoting the precipitation of Resins. It is sometimes administered internally, and is sometimes used externally for its irritant or caustic effects.

Also in the preparation of Solutions of: Arsenous Acid, Iron Chloride and Zinc Chloride.

*Diluted Hydrochloric Acid.*—Acidum Hydrochloricum Dilutum, U. S., contains 10 per cent of absolute Hydrochloric Acid. Sp. gr. 1.050.

It is made by mixing 100 Gm. official acid with 219 Gm. of Distilled Water.

*Hydrofluoric Acid*—HF.—Acidum Hydrofluoricum. A haloid acid. Not official.

Obtained by distilling powdered Fluor-spar with Sulphuric Acid in a leaden retort, and condensing the vapors in water. Great care should be observed in the process not to breathe the vapors, as they are highly irritant and poisonous.

*Properties.*—Hydrofluoric Acid is a colorless, mobile, fuming liquid, lighter than water, and highly volatile. It boils at 19.4°C., and is very soluble in water. A solution whose sp. gr. is 1.15 contains 35.37 per cent of hydrofluoric acid and is the kind usually employed in the arts. It is an extremely caustic liquid, and must be preserved in bottles made of gutta-percha or lead. Its principal use is for etching on glass.

*Hydriodic Acid.*—III.—Acidum Hydriodicum. A haloid acid. Not official.

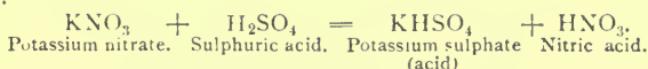
Made by decomposing Iodine in solution with Hydrogen Sulphide, or by double decomposition between an Iodide and an Acid.

# The Oxygen Acids.

The elements Nitrogen, Phosphorus and Sulphur form acids by uniting with both Oxygen and Hydrogen and these are therefore called *oxyacids* in distinction to the *hydriacids*, which the haloid acids sometimes are termed. They comprise Nitric, Phosphoric, Hypophosphorous, Sulphuric and Sulphurous Acids. Also the acids of Arsenic, Boron and Chromium, treated under their respective elements.

*Nitric Acid.*— $\text{HNO}_3$ .—Acidum Nitricum, U. S. A liquid composed of 68 per cent by weight of absolute Nitric Acid and 32 per cent of water. Sp. gr. 1.41.

It is usually obtained by reacting on Sodium or Potassium Nitrate with Sulphuric Acid. The reaction is represented by the following equation:



The process is conducted in iron or glass-retorts and the acid is obtained by distillation.

*Properties.*—The pure acid is a strongly fuming, very caustic and corrosive liquid, of a pungent, suffocating odor, and strongly acid reaction. It rapidly absorbs moisture from the air, and on account of this and its corrosive properties must be kept in tight-fitting glass-stoppered bottles. It acts powerfully on organic tissues, and colors such substances as horn, hair, skin, nails, wool and silk a bright yellow color. It acts energetically on copper, evolving in the process red fumes of nitrogen tetroxide, and yielding a green solution of copper nitrate.

*Uses.*—For dissolving various metals; as an oxidizing agent; for preparing certain nitrates; in the preparation of Nitrous Ether and Amyl Nitrite and in medicine to some extent as a caustic.

*Diluted Nitric Acid.*—Acidum Nitricum Dilutum, U. S., contains 10 per cent by weight of absolute Nitric Acid. Sp. gr. 1.057.

It is made by mixing 100 Gm. Nitric Acid with 580 Gm. Distilled Water.

*Nitrohydrochloric Acid.*—Acidum Nitrohydrochloricum, U. S. A mixture of 18 volumes of Nitric Acid and 82 volumes of Hydrochloric Acid; called Aqua Regia, because of its power to dissolve gold.

The acids, when mixed, should be kept in glass-stoppered bottles, not more than half-filled. The liquid assumes a golden color and gives off chlorine gas to which its power of dissolving gold is due.

It is also called Nitromuriatic Acid.

*Diluted Nitrohydrochloric Acid.*—Acidum Nitrohydrochloricum Dilutum, U. S., is a mixture of 4 volumes of Nitric Acid, 18 volumes of Hydrochloric Acid, and Distilled Water 78 volumes.

The water is added to the acids after the reaction has ceased.

It is frequently given internally in conjunction with bitter tonic medicines.

### ACIDS OF PHOSPHORUS.

There are five different acids of phosphorus:

Hypophosphorous acid,  $\text{H}\text{P}\text{H}_2\text{O}_2$ .

Phosphorous acid,  $\text{H}_3\text{PO}_3$ .

Orthophosphoric acid,  $\text{H}_3\text{PO}_4$ .

Pyrophosphoric acid,  $\text{H}_4\text{P}_2\text{O}_7$ , and

Metaphosphoric acid,  $\text{HPO}_3$ .

Those of most importance to the pharmacist are Metaphosphoric Acid, or the co-called "Glacial" Phosphoric Acid, and the official Orthophosphoric Acid.

*Metaphosphoric Acid.*— $\text{HPO}_3$ —Glacial Phosphoric Acid. This may be obtained from ordinary or orthophosphoric acid by heating it until water is no longer given off, according to the equation:



In practice, it is usually obtained by treating calcined bones (Calcium Phosphate) with dilute Sulphuric Acid, neutralizing the filtered liquid with ammonia and evaporating the liquid freed from the precipitate to dryness and heating to redness. The fused acid is poured upon polished iron-plates and obtained in flat pieces or molded into pencils. The acid thus prepared, though containing some sodium, is sufficiently pure for some of the purposes of pharmacy.

*Phosphoric Acid.*—Orthophosphoric Acid— $\text{H}_3\text{PO}_4$ —Acidum Phosphoricum, U. S., a liquid composed of not less than 85 per cent by weight of absolute Orthophosphoric Acid and 15 per cent of water. Sp. gr. 1.71.

It is prepared from Phosphorus and Nitric Acid in the presence of Water; by the aid of heat the Phosphorus is oxidized by the Nitric Acid, the excess of Nitric Acid driven off and the liquid concentrated by evaporation.

*Properties.*—The official acid is a colorless, odorless liquid, with a strongly acid taste and reaction. When heated gradually it loses water until, when a temperature of about 200°C. is reached, decomposition occurs and it is converted first into a mixture of pyrophosphoric and metaphosphoric acids, and finally into metaphosphoric acid.

*Tests.*—Metaphosphoric and orthophosphoric acids are readily distinguished from each other when in solution, by the following tests: *Meta-*

*phosphoric acid* yields with nitrate of silver a transparent gelatinous precipitate, with barium and calcium chlorides white precipitates, and it has the property of coagulating albumen. *Orthophosphoric acid*, if ammonia be added, yields with nitrate of silver a yellow precipitate, does not form precipitates with either calcium or barium chlorides, and does not coagulate albumen.

*Diluted Phosphoric Acid*.—Acidum Phosphoricum Dilutum, U. S., contains 10 per cent of Orthophosphoric Acid and has a sp. gr. of 1.057.

It is made by mixing 100 Gm. official acid with 750 Gm. Distilled Water.

*Uses*.—In Syrup of the Phosphates of Iron, Quinine and Strychnine and several unofficial preparations, such as Compound Solution of Phosphates, etc.

In weak solutions containing an excess of phosphoric acid a fungoid growth is formed which cannot be prevented except by the addition of a little hydrochloric acid; it may be retarded, however, by keeping such preparations in small, well-filled bottles, in a dark place.

*Diluted Hypophosphorous Acid*.— $\text{H}_2\text{P}_2\text{O}_5$ .—Acidum Hypophosphorosum Dilutum, U. S.—A liquid composed of about 10 per cent by weight of absolute Acid and 90 per cent water. Sp. gr. 1.046.

The acid is formed, combined as hypophosphate, when Phosphorus is boiled with Calcium, or other Alkaline Hydrates, in water. The pure acid is obtained by decomposing the hypophosphate with a stronger acid.

The process of the National Formulary consists of mixing a solution of Potassium Hypophosphate with an alcoholic solution of Tartaric Acid. Potassium Tartrate, insoluble in alcohol, precipitates, the Hypophosphorous Acid is set free and may be obtained in solution of the desired strength by evaporating the alcohol and diluting the liquid with distilled water to the required measure. A concentrated solution, 50 per cent, may be obtained by careful evaporation.

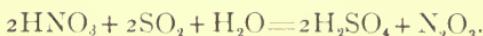
*Uses*.—As a substitute for Hypophosphites in doses from 0.5 to 4 C.C. in syrup.

# The Acids of Sulphur.

*Sulphuric Acid.*— $\text{H}_2\text{SO}_4$ —Acidum Sulphuricum, U. S. A liquid composed of not less than 92.5 per cent by weight of absolute Sulphuric Acid and not more than 7.5 per cent of water. Sp. gr. 1.835.

This is the most important and useful of all acids; it is used in almost innumerable processes in the chemical arts; by means of it the great majority of the other acids are prepared; and its manufacture constitutes a very important branch of modern industry. The compounds of sulphuric acid or Sulphates, are very numerous and important, some of them existing in nature and others being products of the laboratory.

*Sources.*—The acid may be obtained by the “roasting” of sulphides, such as iron pyrites, or by burning Sulphur in a leaden chamber so arranged that the fumes of Sulphur, Sulphur Dioxide,  $\text{SO}_2$ , come in contact with water,  $\text{H}_2\text{O}$ , in the form of vapor, and Nitric Acid,  $\text{HNO}_3$ :



The nitrogen trioxide,  $\text{N}_2\text{O}_3$ , combines with Water and Oxygen and Sulphur Dioxide to form Sulphuric Acid with the liberation of the trioxide. This Nitrogen Trioxide acts as a continuous carrier of Oxygen from the Air to the Dioxide, being re-formed as soon as the Sulphuric Acid is produced.

The nitrogen trioxide is generated by the action of Sulphuric Acid on crude Sodium Nitrate, and it is evident that a small quantity of it will suffice for the production of a large quantity of Sulphuric Acid. The acid produced by this process is allowed to accumulate in the bottom of the leaden chamber until it acquires a specific gravity of 1.55 and contains about 64 per cent of pure acid. This liquid, further concentrated in leaden evaporating pans until it acquires a specific gravity of 1.71 and contains 78 per cent of real acid, constitutes the common brown “Oil of Vitriol” of commerce.

Further concentration of the acid is effected by evaporation in platinum vessels.

*Purification.*—The product thus obtained not only contains considerable water but also frequently Arsenic derived from the sulphur ores used in generating the  $\text{SO}_2$ , and Lead Sulphate derived from the leaden chamber and evaporating pans of the same material.

To get rid of these impurities the commercial product is distilled in glass retorts until about one-third is passed over. The receiver is now changed

and the remainder distilled nearly to dryness. The product thus obtained is free from the other impurities, but still contains some water which cannot be got rid of by distillation.

*Properties.*—The pure acid thus obtained is an inodorous, colorless, and oily-looking liquid of strong acid reaction, and is intensely corrosive and caustic. It is miscible in all proportions with water and alcohol, and the mixture develops considerable heat; for this reason the acid should be poured into the water instead of the reverse when these are mixed. As it has a strong affinity for water, it chars or blackens many organic substances, as sugar, by abstracting from them the elements of water, especially when heated with them. It reacts so violently with volatile oils, such as Oil of Turpentine, as to sometimes cause explosion.

The impurities of the acid and their detection are fully described in the U. S. Ph.

*Aromatic Sulphuric Acid.*—Acidum Sulphuricum Aromaticum, U. S., consists of Sulphuric Acid, 100 parts; Tinct. of Ginger, 50 parts; Oil of Cinnamon, 1 part, and Alcohol enough to make 1000 parts by volume, (C.C.).

The directions given in the U. S. Ph. to add the sulphuric acid *gradually to* 700 parts of alcohol should be followed explicitly, for if the alcohol be added to the sulphuric acid, or if the sulphuric acid be added rapidly to the alcohol, accidents are liable to occur from the great heat developed. This preparation has a sp. gr. of about 0.939 and contains about 20 per cent of absolute acid.

*Diluted Sulphuric Acid.*—Acidum Sulphuricum Dilutum, U. S., contains 10 per cent by weight of Sulphuric Acid. Sp. gr. 1.07. It is made by mixing 100 Gm. of the official acid with 825 Gm. Distilled Water.

*Uses.*—In the preparation of alkaloids, ether, pyroxylin, parchment, etc. Also in the manufacture of acids, such as acetic, nitric, citric and tartaric; having a strong affinity for bases, it unites with them when added to their salts and sets the weaker acid free—as for example, carbonic acid from carbonate of lime or soda in the making of “soda water.” Also for decomposing certain organic compounds, as in purification of chloroform; and for forming sulphates.

*Fuming Sulphuric Acid,* or “Nordhausen Acid,” for some purposes in the arts is preferred to the ordinary acid: a thick, oily, fuming liquid of a sp. gr. from 1.86 to 1.89. It consists of a mixture of perhaps a combination of the ordinary sulphuric acid,  $H_2SO_4$  with sulphuric anhydride,  $SO_3$ , and is obtained by distilling in earthenware retorts basic Ferric Sulphate,  $Fe_2S_2O_9$ , the product of roasting common Green Vitriol,  $FeSO_4 \cdot 7H_2O$ .

*Sulphuric Anhydride*,  $\text{SO}_3$ , is a substance obtained by passing Sulphurous Anhydride,  $\text{SO}_2$ , mixed with Oxygen over platinum sponge or platinized asbestos heated to redness. It may also be obtained by distillation of Nordhausen Acid.

It exists in two modifications. One consists of transparent prisms which melt at  $16^\circ\text{C}$ ., and on agitation solidifies at the same temperature. If the melted prismatic crystals be permitted to stand at a temperature a little below  $25^\circ\text{C}$ ., a mass of silky needles will be formed which do not melt at a temperature below  $50^\circ\text{C}$ . They change back to the first modification, however, when melted. In the second form  $\text{SO}_3$  does not redden litmus paper (unless the latter be damp); it may be handled with impunity with dry hands, and does not attack the metals unless moisture be present. If thrown into water it hisses like a hot iron, great heat is developed and  $\text{H}_2\text{SO}_4$  is formed. For convenience and transportation and on account of its purity, it has been proposed to manufacture it on a large scale for most purposes for which pure sulphuric acid is required.

*Sulphurous Acid*.— $\text{H}_2\text{SO}_3$ .—Acidum Sulphurosum, U. S. A liquid composed of not less than 6.4 per cent by weight of Sulphurous Acid Gas (Sulphur Dioxide,  $\text{SO}_2$ ) and 93.6 per cent of Water. Sp. gr. 1.035.

It may be formed in various ways:

- (1) When Sulphur Dioxide,  $\text{SO}_2$ , is brought into contact with Water.
- (2) When Sulphur is burned in the air:  $\text{S} + \text{O}_2 = \text{SO}_2$ .
- (3) Certain Metals, as copper, acted upon by Sulphuric Acid:  $\text{Cu} + 2\text{H}_2\text{SO}_4 = \text{CuSO}_4 + 2\text{H}_2\text{O} + \text{SO}_2$ .
- (4) Sulphur and Sulphuric Acid heated together:  $\text{S} + 2\text{H}_2\text{SO}_4 = 3\text{SO}_2 + 2\text{H}_2\text{O}$ .
- (5) By the decomposition of a Sulphite by Sulphuric Acid:  $\text{Na}_2\text{SO}_3 + \text{H}_2\text{SO}_4 = \text{Na}_2\text{SO}_4 + \text{H}_2\text{O} + \text{SO}_2$ .
- (6) By heating Charcoal and Sulphuric Acid together:  $\text{C} + 2\text{H}_2\text{SO}_4 = 2\text{H}_2\text{O} + \text{CO}_2 + 2\text{SO}_2$ .

It is the latter process which is adopted in the U. S. Ph. The gas thus obtained is passed through a wash bottle and collected in a bottle containing distilled water, in which it is dissolved.

*Properties*.—The official acid is a colorless liquid of a pungent, stifling odor, strongly acid taste and reaction, and first strongly reddens and then bleaches litmus paper.

*Uses*.—In the manufacture of sulphites and as a bleaching agent in the arts; in medicine chiefly for its powerful antiseptic and disinfecting properties.

## The Non-Metals.

The *non-metals* comprise those elements which lack the specific physical characters or properties of the *metals*, such as expansibility, elasticity, tenacity, malleability and ductility.

They are *gaseous*, as Hydrogen, Chlorine; *liquid*, as Bromine, and *solids*, which may be hard and brittle, such as Carbon and Sulphur, or porous and divisible, such as Phosphorus.

Only the elements themselves and their preparations will be here described, their acids having already been treated, and their other compounds, being, as a rule, described under their respective bases; for example: Sodium Chloride under Sodium; Potassium Bromide under Potassium; Mercuric Iodide under Mercury, etc.

The non-metals, or *metalloids*, as they are also preferably called (from *oid*, Gr., like), are usually divided into four groups according to their property of combining with *one, two, three or four* atoms of Hydrogen to form a volatile compound, as follows:

1. Hydrogen, Chlorine, Bromine, Iodine and Fluorine.
  2. Oxygen, Sulphur, Selenium and Tellurium.
  3. Nitrogen, Phosphorus and Arsenic.
  4. Boron, Carbon and Silicon.

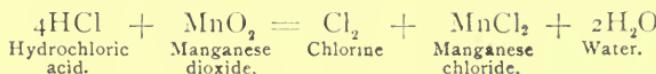
Of these the compounds of Hydrogen and Oxygen have already been described, and the compound of Nitrogen with Hydrogen, known as the radical,  $\text{NH}_3$ , Ammonia, may, because of its character, be considered with the *alkalies*.

Of the elements Selenium and Tellurium there are no compounds of importance.

### CHLORINE.—Cl.

The element Chlorine is a gas which does not occur in a free state in nature, but its compounds are numerous and important.

It is readily obtained by the reaction of Hydrochloric Acid on Manganese Dioxide, as represented in the following equation:



It can also be obtained in many other ways.

*Properties.*—Chlorine is a greenish colored, disagreeable odorous gas, 2.15 times as heavy as air, and under a pressure of 6 atmospheres at  $0^{\circ}\text{C}$ . convertible into a yellow liquid having a sp. gr. of 1.33. The gas dissolves in

about half its volume of cold water, unites with great energy with hydrogen to form Hydrochloric Acid, and owing to its strong affinity for hydrogen is a powerful bleaching agent.

#### PREPARATIONS.

*Chlorine Water.*—Aqua Chlori, U. S.—Is a solution of Chlorine Gas in Distilled Water, and should contain not less than 0.4 per cent of the gas. (For preparation see U. S. Ph.).

*Uses.*—As reagent in the pharmaceutical laboratory, and in medicine for its antiseptic virtues.

*Chlorinated Lime.*—Calx Chlorata, U. S.—Also wrongly called “chloride of lime,” is a compound produced by the action of Chlorine on Calcium Hydrate and containing not less than 35 per cent of available Chlorine.

It has the odor of chlorine, and is a valuable bleaching agent, disinfectant and antiseptic. As is well known, it should not be exposed to the air.

*Solution of Chlorinated Soda.*—Liquor Sodaæ Chloratæ, U. S.—(Labarraque's Solution) an aqueous solution of several chlorine-compounds of Sodium containing at least 2.6 per cent by weight of available chlorine.

Prepared by adding a solution of 150 Gm. Sodium Carbonate to the liquid obtained by filtration from a mixture of 75 Gm. Chlorinated Lime and Water to make 1000 C.C.

*Properties.*—Clear, pale-greenish liquid, sp. gr. 1.052, odor of chlorine, disagreeable alkaline taste, and acting as a bleaching agent upon vegetable coloring matters.

*Uses.*—As a reagent in the pharmaceutical laboratory, and in medicine as a disinfectant and antiseptic, and as a bleaching agent, for the removal of fruit-stains, etc.

Chlorine is the most efficient as it is the most powerful of all disinfectants. It is also the cheapest, and in the form of a good article of chlorinated lime leaves nothing to be desired for all purposes of a general disinfectant and deodorizer.

#### BROMINE.—Br.

Bromine is not found free in nature, but its compounds are not uncommon, occurring in combination with sodium, potassium silver, calcium, magnesium, etc. It occurs in Sea-Water and in the waters of many saline springs. It is usually obtained as a by-product in the manufacture of “Salt” by concentrating the mother liquor containing its salts, the “bittern,” and treating it with Chlorine, which displaces the Bromine from its compounds, as represented in the equation:



*Bromine*.—Br.—Bromum, U. S.—A heavy, mobile, very volatile liquid, with a disagreeable, pungent odor, the vapors when inhaled producing great irritation of the air passages. Its sp. gr. is 2.99. At  $-22^{\circ}\text{C}.$ , it solidifies to a reddish brown solid, and it boils at  $63^{\circ}\text{C}.$  Soluble in 30 parts of water, readily in alcohol. The compounds of bromine closely resemble those of chlorine and iodine.

*Uses*.—Rarely in medicine as an external application and as an antiseptic. Bromine Water, the one-per-cent solution, is used as a reagent.

Bromine must be preserved in small, tightly-fitting glass-stoppered bottles, usually kept in a tin box, and packed in plaster paris. Even with these precautions the whole contents of a vial have been known to escape, owing to its great volatility.

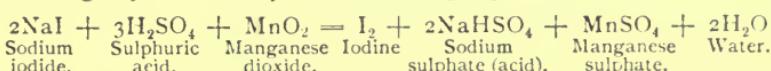
Two preparations of Bromine of indefinite composition are to some extent employed in medicine: Bromine Chloride, a liquid soluble in water; Iodine Bromide, a liquid soluble in 6 to 8 parts of water.

These are both used in very dilute solutions as application in infectious diseases.

#### IODINE.—I.

Like chlorine and bromine, this element does not occur free in nature, and its compounds, though rather widely diffused, do not appear in great abundance. Its salts occur in the Ashes of marine plants, in certain marine animals, and in solution in small quantities in Sea-Water. It occurs also in combination with silver, lead, and in Saline Waters in combination with sodium, magnesium and potassium.

It is principally obtained from "kelp" or the ashes of sea-weeds, by lixiviating them, concentrating the solution, and after the alkaline carbonates, sulphates and chlorides have been removed by crystallization, the iodine is obtained by distilling the mother liquor with Sulphuric Acid and Manganese Dioxide, the decomposition which takes place being represented by the following equation:



*Iodine*.—I—Iodum, U. S.—Dark, lustrous, opaque crystals, belonging to the rhombic system. Sp. gr. 4.948, soluble in 5,000 parts Water; in 10 parts Alcohol. Fusing point between  $113^{\circ}$  and  $115^{\circ}\text{C}.$ ; boiling point about  $200^{\circ}\text{C}.$ , when beautiful violet vapors are given off. Iodine sublimes slowly at ordinary temperatures, and a crystal laid upon the skin imparts a characteristic brown color.

The following preparations of iodine are official:

*Liquor Iodi Compositus*.—“Lugol’s Solution.”—A solution containing Iodine 5 Gm., Potassium Iodide 10 Gm. in 100 Gm. made with Distilled Water.

*Unguentum Iodi.*—A mixture of Iodine 4 Gm., Potassium Iodide 1 Gm., Water 2 C.C. and Benzoinated Lard 93 Gm.

*Tinctura Iodi.*—Iodine 7 Gm., Alcohol to make 100 C.C.

*Amylum Iodatum.*—A mixture of Starch 95 parts, Iodine 5 parts, Water to make 100 parts; was formerly official for testing purposes.

The following compound with an Organic radical may also be mentioned:

*Iodoform.*— $\text{CHI}_3$ .—Iodoformum, U. S., formed by the action of Iodine upon Alcohol, Ether and various compounds of the ether series, in the presence of one of the fixed Alkalies or Alkaline Carbonates.

*Properties.*—Small lemon-yellow, hexagonal crystals in the form of thin, lustrous scales. They are unctuous to the touch, with an odor resembling Saffron, and a peculiar sweetish and unpleasant iodine-like taste. But slightly soluble in water, soluble in 80 parts of alcohol, a sp. gr. of 2.0 and, like iodine, volatilizes slowly at ordinary temperatures.

*Off. Prep.*—*Unguentum Iodoformi*; 10 per cent.

*Uses.*—Principally in the official ointment by substituting petrolatum for benzoinated lard. Also in the form of powder as an external application. The odor may be partially masked by the addition of 4 per cent of thymol, menthol or coumarin. (See National Formulary).

The following preparation of Hydriodic Acid is official:

*Syrup Hydriodic Acid.*—Syrupus Acidi Hydriodici, U. S.—A syrupy liquid containing about 1 per cent by weight of absolute Hydriodic Acid, HI, or about 13 Gm. in 1,000 C.C.

It is made by acting upon Potassium Iodide with Tartaric Acid. Hydriodic Acid is liberated and the Potassium Tartrate formed is precipitated by the Alcohol in the solution at a reduced temperature. The decomposition of the HI into free Iodine is prevented by the presence of the Sugar and a little Hypophosphorous Acid in the Syrup.

*Uses.*—As a substitute for Iodides in doses from 5 to 10 C.C.

The other compounds of iodine which are of importance pharmaceutically are treated of under other headings.

# Sulphur.—Phosphorus.—Arsenic

## SULPHUR.—S.

This is an abundant element in nature, occurring both free and in combination with various metals. Sulphur in a very pure form is found throughout the Rocky Mountain region, but the larger proportion of the sulphur used in medicines comes from the neighborhood of Mt. Ætna. It is usually more or less mixed with earth, but is purified by fusion or sublimation.

*Roll Sulphur* or brimstone is prepared by pouring the melted sulphur into moulds.

*Sublimed Sulphur*.—Sulphur Sublimatum, U. S.—Also called “flowers of sulphur,” is obtained by volatilizing the sulphur and condensing it in a large chamber. It usually contains a small quantity of sulphuric acid, and sometimes also arsenous sulphide as impurities.

Sulphur is insoluble in water, slightly soluble in hot, absolute alcohol, ether, chloroform and benzol, depositing upon cooling in the form of crystals. It is soluble in hot aqueous solutions of the alkalies and alkaline earths, forming sulphides and very soluble in carbon disulphide.

## PREPARATIONS.

*Washed Sulphur*.—Sulphur Lotum, U. S.—Prepared by washing sublimed sulphur thoroughly, first with Water of Ammonia and then with Distilled Water to remove the above-named impurities.

*Off. Prep.*—Pulvis Glycyrrhizæ comp.

*Sulphur Iodide*.—Sulphuris Iodidum, U. S.—Prepared by fusing a mixture of one part of Sulphur and four parts of Iodine, in a flask, to a homogeneous mass.

*Precipitated Sulphur*.—Sulphur Præcipitatum, U. S.—Is prepared by heating together freshly slaked Lime, Sublimed Sulphur and Water to make a solution of Calcium Sulphide, separated by filtration, then adding Hydrochloric Acid to precipitate the sulphur, collecting, thoroughly washing and drying the precipitate.

This article is found in commerce under the name of “Milk,” or “Lac Sulphur,” and consists largely of calcium sulphate, owing to the fact that sulphuric acid, instead of hydrochloric acid, is ignorantly employed to precipitate the sulphur.

*Sulphur Ointment*.—Unguentum Sulphuris, U. S.—30 Gm. Sulphur to 70 Gm. Benzoinated Lard.

## SULPHUR COMPOUNDS.

These are very numerous, and many of them are of importance in pharmacy, but, as they are treated of elsewhere in these lectures, only the following will be mentioned here:

*Hydrogen Sulphide*.— $H_2S$ .—Or Hydrosulphuric Acid.—A gas with a disagreeable odor as of decayed eggs, soluble in water, poisonous when respired in the concentrated form, and blackening paper which has been soaked in solution of lead acetate.

It precipitates many of the metals from solution as *sulphides*, and is therefore valuable as a reagent in pharmaceutical chemistry, the Solution being official.

Hydrogen Sulphide or "Sulphureted hydrogen," as it is most frequently termed, is given off when some metals are dissolved in acids, as in the preparation of solutions of the chlorides of iron, zinc, etc., owing to the presence of Sulphur as an impurity.

## PHOSPHORUS.—P.

This element is not found free in nature, but certain of its compounds are rather abundant. It exists in the bones of animals in the form of Calcium Phosphate, and these constitute its principal commercial source.

It is known in two Allotropic forms:

*Phosphorus*.—Phosphorus, U. S.—Is a transparent, nearly colorless or yellowish, highly refractive body that crystallizes in octahedrons, and at  $15^{\circ}\text{C}$ . has about the consistency of wax. Its sp. gr. is 1.83, it melts at  $44.3^{\circ}\text{C}$ . ( $111.2^{\circ}\text{F}$ .); when heated in atmosphere free from oxygen, it boils at  $290^{\circ}\text{C}$ ., yielding a colorless vapor. It is almost insoluble in water, sparingly soluble in alcohol, more soluble in boiling absolute alcohol, slightly soluble in the volatile oils and ether, freely soluble in chloroform and carbon disulphide, and in about 50 parts of any fixed oil.

It is obtained by distilling a mixture of Calcium Metaphosphate and Charcoal heated to redness, when the Phosphorus is liberated, and escaping as vapor is collected under Water, condensed and, after redistillation to free it from impurities, is formed into cylindrical sticks.

Owing to slow oxidation, it is luminous in the dark, even at ordinary temperatures, but does not inflame until heated to slightly above its melting point. The compounds of phosphorus of pharmaceutical importance are elsewhere considered.

By exposure to the air it soon loses its transparency and becomes "corroded" or covered with a white coating, which is also true when kept under water, not entirely free from air.

*Red or Amorphous Phosphorus* is obtained by the action of heat and

light on the ordinary form. The change takes place at a temperature between 240 and 250°C. If, however, red phosphorus be heated to a temperature of 260°C., it changes back to the ordinary form.

Red phosphorus has a reddish-brown color, and when in powder resembles pulverized iron oxide. In the massive form it has a conchoidal fracture, is much harder than ordinary phosphorus, undergoes no change either when exposed to the air, or when taken into the alimentary canal of an animal, and hence is not poisonous, and it does not take fire at any temperature below 240°C. The commercial product, now extensively used for the manufacture of matches, is usually more or less contaminated with ordinary phosphorus.

#### PREPARATIONS.

*Pilule Phosphori*, each pill containing  $\frac{1}{6}$  milligram or  $\frac{1}{100}$  grain of phosphorus.

*Oleum Phosphoratum*, a one per cent solution of Phosphorus in Expressed Oil of Almonds, containing 10 per cent of Ether.

*Spiritus Phosphori*, a solution of  $\frac{1}{6}$  of one per cent of Phosphorus in absolute alcohol.

*Elixir Phosphori*, made from the Spirit, and contains 1 mg. ( $\frac{1}{71}$  gr.) of Phosphorus in 4 C.C. (1 fl. dram.).

*Uses*.—For internal administration Phosphorus should be largely diluted with an excipient or vehicle, as in the above preparations.

Phosphorus, owing to its inflammable character, must always be kept in a strong bottle and be well covered with water. In order to prevent accidents, which may occur by the accidental fracturing of the bottle, it should be placed in a stone jar in a safe location. The same precaution is necessary to observe in dispensing it, especially to guard against exposing it even for a short time without being covered with water, or mixed with some other substance serving to exclude the air.

#### ARSENIC.—As.

Arsenic occurs in the free state in nature, but much more frequently in a state of combination. Such natural compounds are the sulphides, known as Orpiment and Realgar, arsenous oxide, and various minerals, in which it is found associated with metals. It is frequently present in iron pyrites and native sulphur, and hence finds its way into sulphuric acid. It is also found in certain ferruginous deposits from mineral waters, nearly all of which, as well as sea-water, contain traces of arsenic.

Arsenic in the elementary form occurs in two modifications, amorphous and crystalline, viz: *Amorphous* and *crystallized arsenic*, which differ also in specific gravity. Arsenic volatilizes at 180°C. without previously fusing. It does not change in a dry atmosphere, but when heated it burns with a bluish-colored flame, forming arsenic trioxide, and disseminating the peculiar alliaceous odor. Arsenic and nearly all its compounds are exceedingly

poisonous. In its uncombined state it is chiefly used for the purpose of hardening lead in the manufacture of shot.

#### ARSENIC AND ITS COMPOUNDS.

*Arsine*, or "Arsenette Hydrogen."— $\text{AsH}_3$ .—Is an extremely poisonous gas, having a very peculiar and characteristic smell. It burns with a pale-bluish flame, evolving dense white fumes of arsenic trioxide. On holding a cold piece of white porcelain in the flame, metallic arsenic is deposited as a brown or black shining mirror.

If the gas be passed through a hard-glass tube, which is heated by means of a glass flame placed beneath it, the arsenic is deposited near the heated portion of the tube, in the form of a bright, shining mirror. Upon this delicate reaction depends the application of *Marsh's test*, which is the one most frequently employed for the detection of small quantities of arsenical compounds.

*Arsenic Iodide*.— $\text{AsI}_3$ .—Arseni Iodidum, U. S.—Is a direct combination of Arsenic and Iodine. It is soluble in 7 parts of water and 30 parts alcohol.

It is official in the form of the Iodides of Mercury and Arsenic Solution containing 1 per cent of each.

*Arsenous Acid*.— $\text{As}_2\text{O}_3$ .—Acidum Arsenosum, U. S.—Chemically considered this is not an acid, but *arsenous trioxide*, or arsenous anhydride. When the oxide is dissolved in water, true Arsenous Acid,  $\text{H}_3\text{AsO}_3$ , is formed; hence, in the presence of moisture, arsenous oxide exhibits an acid reaction.

A heavy, white solid, existing either in the amorphous or crystalline condition, and the specific gravity varying according to its condition from 3.738 to 3.689. The amorphous modification has the higher specific gravity, and is transparent or semi-transparent, but on standing becomes opaque by the formation of minute octahedral crystals at the surface. This process goes on gradually from the surface toward the interior until the entire mass becomes crystalline. The appearance of the mass then resembles porcelain. On heating it carefully to a temperature of 218°C. it volatilizes without melting, and the cooled vapor deposits minute octahedral crystals.

*Solubility*.—Its solubility in water varies with its physical condition, sometimes requiring thirty parts and sometimes as high as eighty parts of the solvent. It is slowly but completely soluble in 15 parts of boiling water, and the solution on cooling deposits transparent, regular octahedral crystals. It is slightly soluble in alcohol, very soluble in glycerin, and freely soluble in hydrochloric acid and in solutions of the alkalies and their carbonates.

*Tests*.—When thrown upon ignited charcoal the oxide is reduced, and emits an alliaceous odor. Its aqueous solution affords a lemon-yellow precipitate with a solution of ammonio-nitrate of silver, and a grass-green precipitate with ammonio-sulphate of copper. If the aqueous solution be acidulated with hydrochloric acid, and a stream of sulphureted hydrogen be passed through it, a bright yellow precipitate of arsenous sulphide will be

produced. This precipitate is distinguished from the similar sulphides of antimony and tin by its insolubility in hydrochloric acid and by its solubility in test solution of ammonium carbonate.

The following methods are used for the detection of arsenic in medico-legal analyses: Marsh's test, which depends upon the deposition of a mirror of metallic arsenic formed by *arsine*, or Arseniureted Hydrogen. The tests of Bettendorff, Fleitmann and Gutzeit are more simple and are recognized in the U. S. Ph. (See Reagents, p. 466.)

Arsenous acid is a powerful irritant poison, and as it is the commonest form in which arsenic occurs in commerce, the majority of the cases of arsenical poisoning are produced by it. The maximum safe dose for an adult is about  $\frac{1}{2}$  of a grain (0.006, or 6 mg.). The best antidote is Ferric Hydrate with Magnesia.

(For the preparation of the latter see the U. S. Ph.)

The following Solutions of Arsenic and its Compounds are official: They are all of the uniform strength of one per cent; containing 10 Gm. in 1000 C.C.

Liquor Acidi Arsenosi; Solution of Arsenous Acid.

Liquor Arseni et Hydrargyri Iodidi; Donovan's Solution.

Liquor Potassii Arsenitis; Fowler's Solution.

Liquor Sodii Arsenatis; Solution of Sodium Arsenate.

# Boron.—Carbon.—Silicon.

## BORON.—B.

Boron does not occur in the free state in nature, but is found combined with oxygen and hydrogen to form Boric Acid and also in the form of certain salts of this acid, the most important of which is Borax.

Boron is obtained in two Allotropic forms, one *crystalline*, the other *amorphous*.

The first form consists of monoclinic, octohedra or prisms, which have a luster and hardness exceeded only by the diamond. Their sp. gr. is 2.68.

The second form is a dark brown, tasteless and odorless powder, but slightly soluble in water, a very bad conductor of electricity, and fuses only at a very high temperature.

Neither of these is used in pharmacy. They are rather rare and expensive products of the chemical laboratory.

### COMPOUNDS OF BORON.

*Borax*.— $\text{Na}_2\text{B}_4\text{O}_7 + 10\text{H}_2\text{O}$ .—Sodii Boras, U. S., Sodium Borate.

In crystalline, transparent, shining, colorless, somewhat efflorescent crystals, having a mild, cooling, and somewhat alkaline taste and reaction. Soluble in 16 parts of water at  $15^{\circ}\text{C}$ . in one part of glycerin at  $80^{\circ}\text{C}$ ., insoluble in alcohol; when heated parting with its water of crystallization, first swelling up into a porous mass and then fusing into a transparent glass.

*Uses*.—In various analytical operations in the laboratory, and in medicine, as ingredient of detergent antiseptic washes such as the Glycerite of Borax, and Honey of Borax, both formerly official. Borax is largely used in the powdered form to destroy cockroaches, etc. In the form of Boro-glyceride it is used extensively as an antiseptic dressing, and to preserve meats and vegetables.

*Boric Acid*.—Acidum Boricum, U. S.—A tribasic acid having the formula  $\text{H}_3\text{BO}_3$ .

Transparent, shining, six-sided plates, which are somewhat unctuous to the touch, permanent in the air, odorless, bitterish, feebly acid, changing blue litmus paper to red, and turmeric paper to brown, the brown color of the latter not being altered in the presence of free hydrochloric acid. At  $15^{\circ}\text{C}$ . it is soluble in 25.6 parts of water, and at  $100^{\circ}\text{C}$ . in 3 parts. It is soluble in 15 parts of alcohol at  $15^{\circ}\text{C}$ . and in 5 parts of boiling alcohol and in 10 parts glycerin.

*Sources*.—The principal commercial source of boric acid is the

steam jets or fumaroles that issue from the earth in some districts in Tuscany. The acid that issues in these jets collects in the waters of the lagoons or lakelets formed near the orifices whence the jets issue, and is obtained in the crystalline form by evaporation. Borax is produced by treating the concentrated solution with Sodium Carbonate. Borax occurs as a crystalline deposit in a lake in California, and is also prepared from various borates, found in Nevada and South America.

*Pharm. Uses.*—Chiefly valuable for its anti-fermentative and anti-putrescent properties. It is sometimes administered internally, but more commonly as an external application, combined with an absorbent powder such as starch; or in solution or in the form of ointment prepared with petrolatum. Owing to the difficulty with which it is obtained in fine powder in the preparation of ointments, the acid should be first triturated with a portion of the fused fat in a hot mortar before the whole of the fat is incorporated. Boric acid may be obtained in the dry powdered form by triturating it with a few drops of ether or glycerin. A saturated solution in hot water gradually poured into a large quantity of cold water with constant stirring, yields the acid in a fine state of division.

*Preparations.*—Boro-glyceride prepared by heating 62 parts of boric acid with 92 parts of glycerin to 150° C., until aqueous vapors cease to rise.

As this congeals to a gelatinous mass, inconvenient to dispense, it is chiefly used in 50-per-cent solution of glycerin, the Glyceritum Boroglycerini of the U. S. Ph.

#### CARBON.—C.

This element exists in three modifications, diamond, graphite and charcoal. The two former are of but slight importance in pharmacy, but Charcoal, on account of the property it possesses of condensing large quantities of oxygen and other gases on the surface of its particles, has important uses. By virtue of this property it absorbs the foul-smelling gases produced by the decay of organic matter and causes their oxidation, bleaches solutions containing organic coloring matter, etc.

*Animal Charcoal.*—Carbo Animalis, U. S.—This is prepared by burning the bones of Animals with a limited supply of Air.

It occurs in the granulated form, which is best adapted to pharmacal uses, and as a dull black powder. When a portion of it is ignited in the open air, a white residue, called bone-ash, remains. This ash constitutes about 85% of the weight of the charcoal and should be almost completely soluble in hydrochloric acid with the aid of heat.

*Purified Animal Charcoal.*—Carbo Animalis Purificatus, U. S.—

Consists of ordinary animal charcoal from which the Bone-Ash has been removed by boiling it with Hydrochloric Acid, leaving the nearly pure carbon residue.

*Wood Charcoal.*—Carbo Ligni, U. S.—This is prepared by burning Wood with a limited supply of Air, until all the volatile portions have been driven off or consumed.

For pharmaceutical purposes that prepared from *soft* wood is preferred, its chief use being as an ingredient in Dentifrices and sometimes internally as an antacid.

#### CARBON COMPOUNDS.

These are very numerous and important. All *Organic compounds* come under this head. Of the organic compounds, Carbon Dioxide (carbonic acid) and Hydrocyanic Acid only will be treated here; the carbonates will be treated under their respective metals.

*Carbon Disulphide.*—CS<sub>2</sub>.—Carbonei Disulphidum, U. S.—Or Carbon Bisulphide, as it is commonly termed. A clear, colorless, strongly refractive, very volatile and inflammable liquid, having a strong, disagreeable odor and a sharp aromatic taste. It is almost insoluble in water, and its sp. gr. is 1.268. It is prepared by adding Sulphur to Charcoal heated to redness, and condensing the vapor.

It has anesthetic properties, but its principal pharmaceutical uses are as a solvent; caoutchouc, iodine and some other substances, almost insoluble in ordinary solvents, being readily soluble in it.

*Carbonic Acid.*—Acidum Carbonicum.—This is a dibasic acid having the formula H<sub>2</sub>CO<sub>3</sub>. It is not stable at ordinary temperatures, decomposing into H<sub>2</sub>O and CO<sub>2</sub>, hence it is mainly known through its compounds, the *carbonates*.

When Carbon Dioxide is forced into water, as in charging soda fountains, the water acquires a pleasant acid taste, and a slight acid reaction, which is doubtless due to the formation of carbonic acid by the union of the carbon dioxide with water. Carbonic acid is a feeble acid, being readily displaced from its combinations by the mineral and many of the organic acids. As the displaced acid escapes it is immediately decomposed, and the escaping gas, CO<sub>2</sub>, produces effervescence. Frequently the chemical affinity between the carbonic acid and the base is so feeble in the carbonates that a moderate heat suffices for their decomposition. Calcium carbonate affords a familiar illustration.

*U.*.—Although carbonic acid, save in the form of carbonated waters, has little use in pharmacy, many of the carbonates are of great importance. (These are treated under the metals with which it forms compounds).

*Hydrocyanic Acid.*—HCN.—Acidum Hydrocyanicum.—Carbon and Nitrogen unite to form the Compound radical *Cyanogen*, CN. With Hydrogen this forms an acid, Hydrocyanic Acid, HCN, which although containing Carbon and therefore an *Organic Acid*, may be treated here.

It occurs naturally in some vegetable structures, as in bitter almonds, cherry laurel, etc., but for the purposes of pharmacy it is obtained by distilling Potassium Ferrocyanide (prussiate) with Sulphuric Acid and Water (hence also the name prussic acid). It may also be readily obtained from the Silver Cyanide by agitating the salt with dilute Hydrochloric Acid. (See U. S. Ph.).

The pure anhydrous acid is a colorless, very mobile and volatile liquid, having the odor of bitter almonds. It is one of the most deadly of poisons, and when taken internally so small a dose as .05 of a grain has been known to produce death. Its soluble salts are also for the most part highly poisonous. All preparations of it must be handled, therefore, with the greatest care.

The diluted acid is the only kind used in medicine:

*Diluted Hydrocyanic Acid.*—Acidum Hydrocyanicum Dilutum, U. S.—Prussic Acid.—A liquid composed of 2 per cent by weight of absolute Acid, HCN, and 98 per cent of Water.

As the acid is highly volatile, the solution will rapidly deteriorate unless kept in small, dark, amber-colored, cork-stoppered vials in a cool place. It cannot even with these precautions be kept very long without deterioration, as the acid is slowly decomposed and it should therefore be replaced at least once yearly.

*Uses.*—The official dilute acid has a restricted use in medicine, and may be given in doses of 2 or 3 minims.

#### SILICON.—Si.

Silicon is never found in the free state in nature, although the most abundant of all the solid elements. It exists in combination with oxygen as silicon dioxide or silica,  $\text{SiO}_2$ , which is known in the crystalline condition as opal, flint, sand, etc. In the form of salts, it forms a large and important class of minerals termed silicates. In combination with oxygen, it is widely distributed in the vegetable kingdom, being found in the ashes of plants, and in the stems of cereals.

*Sodium Silicate.*— $\text{Na}_2\text{SiO}_3$ .—Is official in the form of aqueous solution containing about 60 per cent of the salt; also known as "Soluble Glass." Sp. gr. 1.30 to 1.40.

*Liquor Sodii Silicatis.*—Solution Sodium Silicate, used chiefly for surgical purposes, in the preparation of mechanical dressings and as a cement.



# Ammonium and Its Compounds.

The combination of Nitrogen and Hydrogen, known as *Ammonium*,  $\text{NH}_4$ , is not found free and has never been isolated.

The compound known as *Ammonia Gas*,  $\text{NH}_3$ , occurs in the atmosphere, in natural waters and in the Earth.

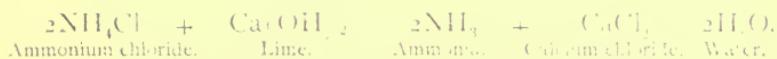
Its chief source is a product of the destructive distillation of wood and coal, and from this all its compounds are directly obtained.

Its compounds are frequently classed with the *alkalies*, and its general characters are the same, except in one important particular, namely: That all its compounds are *volatile* at a moderate temperature.

Salts of Ammonium evolve ammonia gas when heated with alkali hydrates, the gas forms white vapors with Hydrochloric Acid, condensable into Ammonium Chloride, and, similarly to the Alkalies, it *saponifies* fats and *restores* vegetable blues that have been reddened by Acids.

## AMMONIA AND ITS PREPARATIONS.

*Ammonia*.— $\text{NH}_3$ .—The gas may readily be obtained by heating any Ammonium salt with an alkali, such as Soda or Potash, or an alkaline earth, such as Lime. The following equation indicates the reaction:



Ammonium Chloride, ("Sal Ammoniac") eminiate of ammonia being cheap, is the salt usually employed for the purpose, and in order to insure the complete decomposition of the salt an excess of lime is used.

Ammonia is a colorless gas, with a pungent odor, strong alkaline reaction, and a sp. gr. taking air as the standard of 0.586. It neutralizes and forms stable compounds with the acids. All Ammonium compounds are completely volatilized by heat.

By cold and pressure it may be reduced to the liquid state, which forms a colorless, highly refractive, mobile liquid which boils at  $-33.7^\circ\text{C}$ . At  $-75^\circ\text{C}$ . becomes converted into a crystalline solid. Liquid ammonia is quite extensively used as a solvent for, and in the manufacture of,

It is highly soluble in water, this liquid taking up, at  $0^\circ\text{C}$ . under the normal atmospheric pressure, more than 1,000 volumes of the gas. The gas is probably not merely dissolved in water, per-

enters into combination with water, forming  $\text{NH}_4\text{HO}$ , or Ammonium Hydrate. This compound has, however, never been isolated.

*Water of Ammonia.*—Aqua Ammoniae, U. S.—An aqueous solution containing 10 per cent by weight of the gas. Is a colorless, transparent liquid of a very pungent odor, and a strongly acid alkaline taste and alkaline reaction. Its sp. gr. at  $15^{\circ}\text{C}$ . is 0.960.

*Off. Prep.*—Linimentum Ammoniae; Spiritus Ammoniae Aromaticus.

The strength of the weaker Ammonia Water of commerce is usually designated by one or more F.'s, an arbitrary standard. The number of F.'s attached to a label usually does not indicate the percentage strength of the ammonia water contained in it. Although the mark of 4 F. is supposed to mean stronger water of ammonia, or 28 per cent, it usually indicates about 18 per cent. Pharmacists should insist that Ammonia Water be designated by its *percentus strength* only, when purchasing.

*Stronger Water of Ammonia.*—Aqua Ammoniae Fortior, U. S.—An aqueous solution containing 28 per cent by weight of the gas. Its sp. gr. is 0.90. It should be kept in a cool place, in tightly-stoppered bottles which are not quite filled, and care should be exercised in opening the bottles. (For tests see U. S. Ph.)

*Off. Prep.*—Spiritus Ammoniae.

*Uses.*—As a precipitant in the preparation of many hydrates and salts, held in solution by acids, for example, ferric hydrate, calcium phosphate, and most of the alkaloids. As a solvent in the extraction of some drugs, and for neutralizing acid solutions. Combined with citric acid it forms double salts with some of the metals, as for example, bismuth and iron, rendering these soluble. It is also used as a general solvent for "grease," and in the preparation of many pharmaceutical products.

#### AMMONIUM COMPOUNDS.

Ammonia gas is a by-product of gas-works, being found in the so-called gas-liquor. By heating this liquor with Lime, in a retort, the gas is evolved and may be at once conducted into water to form Ammonia Water, or into aqueous solution of an Acid. If Sulphuric Acid be used Ammonium Sulphate is formed; if Hydrochloric Acid, the Chloride of Ammonium or "Sal Ammoniae" is obtained by crystallization.

From either of these compounds all the other Ammonium Compounds are produced.

*Ammonium Sulphate.*— $(\text{NH}_4)_2\text{SO}_4$ —Ammonii Sulphas.—Colorless, transparent, rhombic prisms, permanent in air, odorless, possessing a sharp saline taste, and neutral reaction. Soluble in 1.3 parts of water at  $15^{\circ}$ , insoluble in absolute alcohol. It is not official.

*Ammonium Chloride.*— $\text{NH}_4\text{Cl}$ .—Ammonii Chloridum, U. S.

**Muriate of Ammonia.**—In the crude state it occurs in tough, fibrous crystalline masses. The pure official salt is a snow-white crystalline powder, with a cooling, saline taste, without odor, a slightly acid reaction, permanent in the air, and on heating with caustic potassa or lime, evolving ammonia gas.

*Preparation.*—The pure or granulated form, the only kind now official, is prepared from the crude Sal Ammoniac by dissolving it in about twice its weight of hot water, adding a little chlorine water to convert any ferrous chloride present into a ferric salt, then ammonia in excess, which precipitates the iron present in the form of ferric hydrate. The liquid is then filtered, and the clear filtrate evaporated until a pellicle forms, when it is allowed to cool and crystallize; or it may be evaporated nearly to dryness in a shallow vessel, and the granular, crystalline powder dried between sheets of filter paper. Its preparation is well adapted to the beginner as the first chemical to be made in the pharmacy.

*Off. Prep.*—*Trochisci Ammonii Chloridi.*

**Ammonium Carbonate.**— $(\text{NH}_4)\text{HCO}_3$ .  $(\text{NH}_4)(\text{NH}_2)\text{CO}_2$ . **Ammonii Carbonas, U. S.**—This salt is probably in reality a mixture of acid carbonate and carbamate of ammonium as expressed in the above formulas, instead of a true carbonate.

White, translucent masses, with odor of ammonia, and giving out both ammonia and carbon dioxide on exposure to the air. Taste saline, reaction alkaline. It must be kept in tightly closed jars, to protect it from the air.

Made by heating a mixture of Chalk and Ammonium Chloride. The Ammonium Carbonate sublimes and is collected in the cooler parts of the vessel, or in a receiver.

*Uses.*—As an ingredient in “smelling salts” and in the two official preparations. In conjunction with syrups of acid reaction, such as sennill and glycyrrhiza for cough syrups, the ammonium carbonate reacting with the acids should be gradually dissolved in a mortar, with the addition of water when permissible, so as to prevent frothing.

*Off. Prep.*—*Liquor Ammonii Acetatis; Spiritus Ammoniae Aromaticus.*

**Ammonium Acetate.**— $(\text{NH}_4)\text{C}_2\text{H}_3\text{O}_2$ .—A solution made by saturating dilute Acetic Acid with Ammonium Carbonate, constitutes Liquor Ammonii Acetatis, U. S., or Spirit of Mendererus.

This preparation should always be prepared extemporaneously, since when fresh it is a most refreshing draught to feverish patients, while it rapidly loses its carbonic acid, and then possesses a disagreeable saline, frequently decidedly alkaline, taste. The pure acid (U. S. Ph., not the commercial so-called No. 8) should be used, properly diluted, and the ammonium carbonate, in translucent pieces, gradually added with constant stirring, until only a slight effervescence

takes place. The solution is then poured in a vial, which must be well corked so as to preserve the carbonic acid. When administered, the preparation, owing to its sparkling character and pleasant acidity, forms a cooling and most agreeable potion.

*Off. Prep.*—Mistura Ferri et Ammonii Acetatis.

The following are all made by saturating their respective Acids with Ammonia Water and obtaining the Salt by crystallization.

They may be made extemporaneously (as wanted) and kept in solution. By referring to table on page 551 of the U. S. Ph., the respective quantities of Acids and Alkalies required to produce 100 parts of the Salt may be seen at a glance.

*Ammonium Benzoate.*— $(\text{NH}_4)\text{C}_7\text{H}_5\text{O}_2$ .—Ammonii Benzoas, U. S.—A white crystalline salt having a slight odor of Benzoic Acid, and a saline, bitter and highly acrid taste, made by saturating Benzoic Acid with Ammonia Water and evaporating, keeping the ammonia in excess until crystals begin to form.

Soluble in 5 parts of water and 28 parts of alcohol.

*Ammonium Bromide.*— $\text{NH}_4\text{Br}$ .—Ammonii Bromidum, U. S.—A transparent crystalline or white granular salt, changing to yellowish on exposure to the air, and having a pungent saline taste.

It is prepared by agitating iron wire with a solution of bromine until the odor of bromine can no longer be perceived, thus forming Ferrous Bromide, adding Ammonia Water to excess, filtering and evaporating to dryness.

*Uses*.—Mostly in the form of Elixir containing 10 grains to the fluid dram Soluble in 1 5 parts of water and 30 parts of alcohol.

*Ammonium Citrate*.—Made by saturating a solution of Citric Acid with Water of Ammonia so as to be of a faint alkaline reaction, recognized by a slight odor of ammonia.

*Uses*.—As a solvent for many salts especially in Elixirs; with iron and bismuth it forms soluble double compounds, viz: Ammonio-citrate of iron and ammonio-citrate of bismuth. These will be treated under their respective metals.

*Ammonium Iodide*.— $\text{NH}_4\text{I}$ .—Ammonii Iodidum, U. S.—A white, granular, deliquescent salt, changing to yellow or yellowish-brown on exposure to the air, in which form it should not be dispensed, odorless when white but with a faint odor of iodine when colored by exposure; a sharp saline taste, and a neutral reaction. It is prepared by saturating Ammonia Water with Hydriodic Acid. Soluble in 1 part of water and 9 parts alcohol.

*Uses*.—A spirit, prepared by mixing an alcoholic solution of iodine with strong ammonia water in such proportion as to yield a colorless product, consisting of ammonium iodide and ethyl iodide. This has been erroneously

termed "decolorized tincture of iodine." [For formula see the Dispensatory and National Formulary.]

*Ammonium Nitrate.*— $\text{NH}_4\text{NO}_3$ .—Ammonii Nitratas, U. S.—Colorless, usually rhombic prismatic crystals, somewhat deliquescent, odorless, with a sharp bitter taste and neutral reaction. Dissolves at the ordinary temperature in half its weight of water and in 20 parts of alcohol, and is much more freely soluble in both at their boiling points. Completely resolved by heat into nitrous oxide (laughing gas) and water.

Made by saturating dilute Nitric Acid with Ammonia Water or with Ammonium Carbonate.

*Uses.*—In dentistry for the production of "Laughing Gas."

*Ammonium Oxalate.*—Made by saturating a solution of Oxalic Acid with Ammonia, and crystallizing. It is of importance in pharmaceutical chemistry as a test for calcium, and the Test Solution is official.

*Ammonium Phosphate.*— $(\text{NH}_4)_2\text{HPO}_4$ —Ammonii Phosphas.—Colorless, translucent, prismatic crystals, evolving ammonia on exposure to air, odorless, possessing a cooling saline taste, and neutral or slightly alkaline reaction.

Made by adding an excess of Ammonia Water to dilute Phosphoric Acid, and evaporating slowly until crystals form.

*Ammonium Sulphide.*—A solution made by saturating Ammonia Water with Hydrogen Sulphide. It is of importance in pharmaceutical chemistry as a test, and the solution is official.

*Ammonium Valerianate.*— $(\text{NH}_4)\text{C}_5\text{H}_9\text{O}_2$ .—Ammonii Valerianas, U. S.—White or colorless, tabular crystals, deliquescent in moist air, possessing the peculiar odor of valeric acid, a sharp, sweetish taste and a neutral reaction. Freely soluble in both water and alcohol.

It is made by passing dry Ammonia Gas into Valeric Acid when the salt crystallizes out. On a large scale, however, it is prepared from Fusel Oil (amylic alcohol), which bears the same relation to valeric acid as ordinary alcohol bears to acetic acid, and like the last named alcohol is converted into its respective acid by oxidation.

*Uses.*—Principally in the form of Elixirs containing two grains to the fluid dram. Solutions of the salt must be carefully neutralized with ammonia so as to prevent the volatilization of the acid, to which the disagreeable odor is due [See National Formulary.]

# Potassium.

Although potassium does not occur free in nature, it is a widely distributed and rather abundant metal. It occurs in many silicates, as Feldspar, Lencite, etc.; as Chloride in certain localities, as at Stassfurt, Germany, and also in solution in small proportion in Sea-Water, and in the waters of certain mineral springs; in the form of Nitrate in various soils, and in other combinations in most soils; and in the tissues of plants.

*Potassium*.—K.—From Kalium, the older name for the element. Potassium is developed from the Anglo-Saxon Pot-ash, the residue in a pot in which a solution of wood-ash had been evaporated.

It is obtained in the metallic form by heating to a white heat a mixture of Charcoal and Potassium Carbonate, and rapidly cooling the vapor of potassium as it escapes from the crucible, by conducting it into a properly constructed receiver without access of air. The following equation represents the reaction which takes place:



It may also be prepared on a small scale by the electrolysis of Potassium Cyanide.

*Properties*.—A silvery white metal, sp. gr. 0.875, brittle, and possessing a crystalline fracture at 0°C., but of a waxy consistency, and easily cut at 15°C., melting at 62.5°C., oxidizes readily on exposure to damp air, and forms the hydrate with such rapidity when thrown upon water, that the hydrogen set free from the latter is inflamed, and is colored a characteristic violet by the volatilized potassium oxide, which is produced. It must be preserved under Benzin or some other liquid that does not contain oxygen.

*Uses*.—Being a powerful reducing agent, it has some important uses in the chemical laboratory, but has no pharmaceutical importance. Several of its compounds, however, are of great importance.

## NATURAL POTASSIUM COMPOUNDS.

The *natural* Potassium Compounds are the Chloride, Sulphate, Nitrate and Bitartrate.

*Potassium Sulphate*.— $K_2SO_4$ .—Potassii Sulphas, U. S.—Occurs native in Sea-Water; in certain mineral waters, mixed with Common Salt, in some salt beds, and is obtained as a by-product in certain manufactures.

In colorless, transparent, six-sided rhombic crystals. It does not change on exposure to the air, has a cooling, saline taste, and is neutral to test

paper. Its sp. gr. is 2.648, it is soluble in 4 parts of water at 15° C. much more freely soluble in boiling water, and nearly insoluble in alcohol.

*Uses.*—In medicine, rarely, as a purgative. Owing to the hardness of the crystal, this salt was formerly used in the preparation of Dover's Powder for the purpose of facilitating comminution of the active ingredients; it was replaced by sugar of milk in the U. S. Ph., '80.

*Potassium Sulphite*— $K_2SO_3 \cdot 3H_2O$ .—*Potassii Sulphis.*—Made by passing a current of Sulphurous Acid gas into a solution of Potassium Carbonate. Not official.

In oblique rhombic octahedral crystals. Odor slight, taste bitter, saline and sulphurous, deliquescent, freely soluble in water, but slightly soluble in alcohol. On heating, decomposition takes place, water and sulphurous acid being given off.

*Uses.*—In medicine as an anti-fermentative and anti-putrefactive.

*Potassium Nitrate.*— $KNO_3$ .—*Potassii Nitratas, U. S.*—Commonly called Saltpetre. Usually obtained as a product of fermentation that takes place in soils, rich in certain forms of organic matter. It is common in certain hot countries, as India, Egypt, Persia, some portions of South America, etc., where it occurs as an efflorescence in the soil. This is collected and purified by repeated solution and recrystallization.

Six-sided, usually striated, rhombic prisms, that are colorless, odorless, with a cooling saline taste, containing water enclosed mechanically in the interstices; or a crystalline powder. It is soluble in 3.8 parts water, in 0.4 boiling water and sparingly in alcohol.

At a high temperature saltpetre evolves oxygen and is gradually changed to the nitrite.

*Uses.*—As a diluent in fused Silver Nitrate, as an ingredient in medicated vapors for asthma etc., as a diuretic, and in large doses as a cardiac and nervous sedative. In the arts for Gunpowder, and in domestic practice for curing meat.

*Off. Prep.*—*Charta Potassii Nitratis*, made by saturating paper in a solution of the salt and drying it.

*Potassium Bitartrate.*— $KHC_4H_4O_6$ .—*Potassii Bitartras, U. S.*—Cream of Tartar. Prepared from Argols, or argol, a crystalline deposit formed in grape-juice during the vinous fermentation. It consists of Cream of Tartar associated with Calcium Tartrate and other impurities. The crude product is boiled with water, through which the impurities are largely removed, and then purified by repeated crystallization.

Colorless or nearly colorless rhombic crystals, or a white, gritty powder, odorless, pleasantly acid to the taste, and having an acid reaction. It is soluble in 200 parts of water, in 16 parts boiling water, nearly insoluble in alcohol. It blackens when strongly heated, and gives out the odor of burnt sugar.

As the salt is very liable to adulteration, the pharmacopeial tests for purity should always be applied to samples purchased for medicinal use.

*Uses.*—As the source of Tartaric Acid, and in the preparation of Antimony and Potassium Tartrate, Iron and Potassium Tartrate, Sodium and Potassium Tartrate, and Potassium Tartrate.

In medicine as a laxative, refrigerant, and diuretic. Mixed with some dry powder, such as starch, in conjunction with Sodium Bicarbonate, it is largely used as baking powder. The carbonic acid, by exposure to moisture and heat, is liberated in the process of baking, thus rendering the bread light and porous.

*Off. Prep.*—In *Pulvis Jalapæ Compositus*, Beach's *Diaphoretic Powder*, and as an ingredient in many unofficial mixtures. Popularly as a blood purifier mixed with flowers of sulphur.

From Potassium Bitartrate the following are made:

*Potassium Tartrate.*— $(K_2C_4H_4O_6)_2 + H_2O$ .—*Potassii Tartras*.—Made by neutralizing a solution of Cream of Tartar with Potassium Carbonate. Not official.

Monoclinic, transparent, somewhat deliquescent crystals, with a saline, somewhat bitter taste, and neutral to test paper. When heated, water is given off, and at a higher temperature the mass becomes charred. Very soluble in water.

*Uses.*—In medicine chiefly as an aperient, and in pharmacy as a test for glucose in Fehling's solution.

*Potassium and Sodium Tartrate.*— $KNaC_4H_4O_6 + 4H_2O$ .—*Potassii et Sodii Tartras*, U. S.—This is commonly called Rochelle Salt, and is prepared by saturating a solution of Sodium Carbonate with Potassium Bitartrate, evaporating the solution and crystallizing.

In the form of a white powder, or in transparent rhombic crystals, slightly efflorescent in dry air, odorless, and with a bitterish mildly saline taste. Soluble in 1.4 parts of water at 15°C., and nearly insoluble in alcohol. Melts in its water of crystallization at about 75°C.; at a more elevated temperature it dries and then chars.

*Uses.*—In medicine as a laxative.

*Off. Prep.*—*Pulvis Effervescentis Compositus*.

## POTASSIUM CARBONATE AND OTHER COMPOUNDS.

From Potassium Sulphate the Carbonate is made, and from this in turn all the other Potassium compounds.

*Potassium Carbonate*.— $K_2CO_3$ .—Potassii Carbonas, U. S.—Salts of Tartar.

Obtained by leaching Wood-Ashes and evaporating the lye thus obtained and purifying it; also from Potassium Sulphate which occurs in sea-water, and as mineral in some localities.

White granular powder, or in white solid masses, odorless, with a somewhat caustic and alkaline taste, and alkaline reaction. It is highly deliquescent, and must be kept in well-stoppered bottles. Soluble in one part of water, but is insoluble in alcohol.

*Uses*.—For the general purposes of an alkali, in Sulphureted Potassa and many unofficial preparations. In medicine it is used externally on account of its irritant or caustic effect, and internally as an antacid and diuretic. In large doses an irritant caustic, the proper antidote being dilute acids, such as vinegar.

*Potassium Bicarbonate*.— $KHCO_3$ .—Potassii Bicarbonas, U. S.—Obtained from the carbonate by saturating a solution of the latter with Carbon-Dioxide, filtering, evaporating, and allowing the liquid to crystallize.

Transparent, colorless, monoclinic prisms, permanent in dry air without odor, taste saline and somewhat alkaline. It is soluble in 3 2 parts water, in 2 parts at  $50^{\circ}\text{C}$ .; in solutions above this temperature, Carbon Dioxide, is given off. Almost insoluble in alcohol. Heated to about  $200^{\circ}\text{C}$ ., it gives off water and carbon dioxide, and is converted into the carbonate. An impure variety in the form of a white powder, was formerly sold under the name of Saleratus.

*Uses*.—In many saline draughts, when of acid reaction, to furnish Carbonic Acid by decomposition. For that purpose it is used in the official Solution of Magnesium Citrate.

*Caustic Potassa*.— $KHO$ .—Potassa, U. S.—Potassium Hydroxide, Caustic Potash. Usually obtained by decomposing a solution of Potassium Carbonate by means of freshly slaked Lime. It is commonly sold in sticks or pencils, which are hard, white, very deliquescent, very caustic to the taste, and strongly alkaline in their reaction. At  $15^{\circ}\text{C}$ . it is soluble in one-half its weight of water, and in twice its weight of alcohol.

### PREPARATIONS OF POTASSA.

Liquor Potassæ, containing Potassa 56 parts, and Distilled Water 944 parts.

Potassa cum Calce, made by rubbing together equal parts by weight of Potassa and Lime. “Potassa by alcohol,” a pure unofficial form.

is prepared by precipitating the impurities from a solution of the commercial Potassa with Alcohol.

*Sulphurated Potassa.*—Potassa Sulphurata, U. S.—“Liver of Sulphur.”—Not a definite compound, but a mixture of several, produced by gradually heating a mixture of Sublimed Sulphur, 1 part, and Potassium Carbonate, 2 parts, until effervescence ceases, and cooling the fused mass by pouring it out on a marble slab.

It is, when fresh, composed chiefly of potassium trisulphide and potassium hyposulphite, but usually contains also a small percentage of unchanged potassium carbonate. It rapidly undergoes change, on exposure to the air, and must be kept in tight-fitting, glass-stoppered bottles.

Liver-colored masses, changing to greenish yellow or brownish-yellow on exposure; odor faint, disagreeable, resembling sulphureted hydrogen; taste bitter, alkaline and repulsive.

*Uses.*—In the preparation of Lotions, Ointments, etc., for diseases of the skin or mucous surfaces. Now seldom used internally.

### COMPOUNDS OF POTASSIUM.

*Potassium Chlorate.*— $KClO_3$ —Potassii Chloras, U. S.—Usually obtained by the action of Chlorine on a solution of Caustic Potash, or on a moistened mixture of Potassium Carbonate and Caustic Lime. After saturation with Chlorine the mixture is diluted with Water and then evaporated until crystals begin to form.

Colorless monoclinic prisms or plates, possessing a pearly lustre, neutral to test paper, odorless, and with a cooling, saline taste. Soluble in 16.5 parts of water, in 17 parts of boiling water, very sparingly soluble in alcohol at any temperature. When heated the salt first fuses, then gives off its oxygen, leaving a residue of potassium chloride.

*Uses.*—As a source of oxygen; in the manufacture of Potassium Permanganate, and in medicine chiefly as a remedy for ulcers in the mouth and throat.

*Off. Prep.*—Trochisci Potassii Chloratis; and an unofficial solution containing 2 Gm. (30 grains) of the salt in 33 c.c. (fluid ounce) for dispensing purposes.

*Caution:* Potassium chlorate should be kept in glass-stoppered bottles, and great caution should be observed in handling the salt, as dangerous explosions are liable to occur when it is mixed with organic matter (cork, tannic acid, sugar, etc.) or with sulphur, antimony sulphide, phosphorus, or other easily oxidizable substances, and either heated directly, or subjected to trituration or concussion.

*Potassium Bromide.*— $KBr$ .—Potassii Bromidum, U. S.—Obtained by the reaction of Potassium Carbonate upon a solution of Ferrous Bromide, according to the following equation:

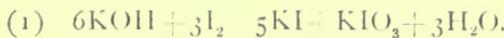


Colorless, cubical crystals, permanent in dry air, odorless, with a saline taste, and neutral reaction. Soluble in 1.6 parts of water, in

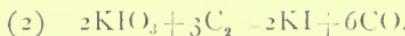
less than its weight of boiling water, and in 200 parts of alcohol. At a dull red heat it fuses, without loss of weight.

*Uses.*—As a sedative, anesthetic, and hypnotic. In various unofficial preparations: Elixir containing 10 grains to the fluid dram, and in a Compound Mixture of Potassium Bromide and Chloral, containing 15 grains of each in one fluid dram, at 1½ grain each, extract Cannabis Indica and extract Hyoscyamus. (See Nat. Form.)

*Potassium Iodide.*—KI.—Potassii Iodidum, U. S.—Obtained by heating Iodine in a solution of Potassa, concentrating by evaporating and treating with charcoal, drying and heating to redness, dissolving in Distilled Water, and crystallizing. The reactions that take place are represented as follows:



Potassium Iodate,  $\text{KIO}_3$ , is poisonous, and is heated with charcoal, when it becomes reduced to iodide:



Colorless, transparent or translucent, cubical crystals, somewhat deliquescent, with a faint, peculiar odor, a saline taste, and neutral reaction. Soluble in 0.75 parts of water, in one-half its weight of boiling water, and in 18 parts of alcohol.

*Uses.*—As a reagent in the laboratory, and in medicine as a resolvent, being the most valuable of all the compounds of iodine. It is usually administered in Compound Syrup of Sarsaparilla, more especially to mask its disagreeable taste. It is also used to make iodine soluble in water or watery mixtures, as in the following official preparations:

*Liquor Iodi Compositus.*: Iodine, 5 Gm.; Potassium Iodide, 10 Gm.; Water, 85 Gm.

*Unguentum Iodi.*: Iodine, 4 parts; Potassium Iodide, 1 part, Water, 2 parts; Benzoinated Lard, 93 parts.

*Off. Prop.*—Unguentum Potassii Iodidi: Potassium Iodide, 12 parts; Sodium Hyposulphite, 1 part; boiling Water, 10 parts; Benz. Lard, 77 parts.

*Potassium Hypophosphite.*— $\text{KPH}_2\text{O}_4$ —Potassii Hypophosphis, U. S.—Obtained by boiling a solution of Potassa with Phosphorus.

Granular powder or white confused crystalline masses, neutral to test paper, odorless, with a sharp saline taste, very deliquescent, soluble in 0.6 parts of water, and in 7.3 parts of alcohol.

*Uses.*—In the preparation of Syrup of Hypophosphites and various unofficial preparations; Elixirs and Cod-Liver Oil Emulsions.

*Potassium Arsenite*, solution.—Liquor Potassii Arsenitis, U. S.—Fowler's Solution.

Made by boiling 1 Gm. of Arsenous Acid and 2 of Potassium Bicarbonate, in 10 c.c. of Water, until solution is complete, and then adding Compound Tincture of Lavender 3 c.c., and Water enough to measure 100 c.c.

*Potassium Bichromate.*— $K_2Cr_2O_7$ .—Potassii Bichromas, U. S.—Obtained from Chrome-ironstone,  $FeOCr_2O_7$ , by roasting it, heating it strongly with Potassium Carbonate and Lime, leaching out the Potassium Chromate thus formed, and converting it into the Bichromate by treating the solution with Sulphuric Acid.

Garnet-red tables or prisms, odorless, with an unpleasant, bitter, metallic taste, and an acid reaction. Soluble in 10 parts of water, insoluble in alcohol, fusible below red heat into a transparent, red liquid, and decomposes at a white heat into oxygen, normal chromate, and chromic oxide.

*Uses.*—As a test in pharmaceutical chemistry (see the official Test Liquid), in the preparation of Chromic and Valerianic Acids. Also in dyeing, and with Sulphuric Acid for coloring liquids in "show bottles." Internally in large doses it is poisonous, chalk, magnesia or soap being the proper antidotes.

*Normal Potassium Chromate*, or yellow chromate of potash,  $K_2CrO_4$ . This occurs in six-sided, lemon-yellow crystals, and is usually prepared by adding Potassium Carbonate to a solution of the Bichromate so long as effervescence is produced.

*Uses.*—Chiefly for the preparation of test solution in pharmaceutical chemistry.

*Potassium Permanganate.*— $KMnO_4$ .—Potassii Permanganas, U. S.—Usually obtained by the reaction of Potassa and Potassium Chlorate on Manganese Dioxide.

Dark purple, or nearly black, rhombic prisms, with a metallic luster, neutral to test paper; permanent in the air, odorless, sweetish and afterward disagreeable to the taste. Soluble in 16 parts of water, forming a deep purple colored solution in 3 parts boiling water. In contact with alcohol it is decomposed.

*Uses.*—Owing to the fact that it readily parts with oxygen in contact with organic matters, it is used as a Disinfectant, in the preparation of washes for foul ulcers, etc., and is also given internally in diphtheria, sore throat, etc. It should be exhibited only with substances free from organic matter, lest it be reduced, and for this reason, when prescribed in the pill form, the excipient should be petrolatum and kaoline or similar non-oxidizable substances.

*Caution.* Potassium Permanganate should be kept in glass-stoppered bottles protected from light and should not be brought in contact with organic or readily oxidizable substances. Mixed with glycerin or similar substances, it may cause explosion.

## ORGANIC COMPOUNDS OF POTASSIUM.

The following are compounds of organic radicals:

*Potassium Acetate*.— $KC_2H_3O_2$ .—Potassii Acetas, U. S.—Made by saturating a solution of Potassium Carbonate with Acetic Acid, and evaporating the solution until crystals are formed.

A deliquescent, crystalline or granular white salt, without odor, and having a mildly pungent and saline taste. Soluble in 0.36 parts of water and 1.9 parts of alcohol, melts to an oily liquid at a temperature of about  $290^{\circ}\text{C}$ ., and at a higher temperature is decomposed, evolving acetic acid, acetone and other volatile products, and leaves potassium carbonate and charcoal. It must be kept in well-stoppered bottles.

*Uses*.—In medicine as a diuretic and diaphoretic.

*Potassium Citrate*.— $K_3C_6H_5O_7 + H_2O$ .—Potassii Citras, U. S.—Obtained by neutralization of a solution of Citric Acid with Potassium Bicarbonate, and evaporating the solution until a granular salt remains.

A white, deliquescent powder or transparent prismatic crystals with cooling, faintly alkaline taste and neutral or slightly alkaline reaction. Soluble in 0.6 parts of water, sparingly soluble in alcohol loses its water of crystallization at  $200^{\circ}\text{C}$ ., and chars.

*Uses*.—As an arterial sedative and a diaphoretic.

*Off. Prep.*.—Liquor Potassii Citratis; a six-per-cent solution of Citric Acid saturated with Potassium Bicarbonate.

The "Neutral Mixture," formerly official, was Lemon-juice neutralized with Potassium Bicarbonate.

*Potassii Citras Effervescent*, U. S.—A mixture of 63 Gm. of Citric Acid, 90 Gm. Potassium Bicarbonate and Sugar to make 200 Gm.

The ingredients are powdered separately, then mixed thoroughly in a warm mortar. The resulting paste is dried rapidly at a temperature not exceeding  $120^{\circ}\text{C}$ . and reduced to a granular powder. The product must be kept in well-stoppered bottles. It is used to furnish effervescent draughts.

*Potassium Ferrocyanide*.— $K_4Fe(CN)_6 + 3H_2O$ .—Potassii Ferrocyanidum, U. S.—From this, in the long run, nearly all the Cyanogen compounds are prepared. It is obtained by heating crude Potash in covered cast-iron pots, into which is thrown a mixture of Iron filings and Carbonaceous matters, such as horn, feathers, dried blood, etc. The fused mass is lixiviated, and the clear liquid evaporated and crystallized.

Large, light-yellow, translucent or nearly transparent, quadratic pyramidal crystals. Soluble in 4 parts of water, in 2 parts boiling water, insoluble in alcohol. Sp. gr. 1.83. Slightly deliquescent, heated to  $60^{\circ}$  begins to part with its water of crystallization, and at 100 it is completely given off, a white powder remaining. It is not poisonous.

*Uses.*—Used in the preparation of Hydrocyanic Acid, the Cyanides, etc., and as a test for iron, zinc and copper.

*Potassium Cyanide.*—KCN.—Potassii Cyanidum, U. S.—Obtained by fusing together proper proportions of dried Potassium Ferrocyanide and Potassium Carbonate, dissolving out the Potassium Cyanide formed and crystallizing it.

Amorphous, or finely crystalline, white masses, deliquescent in moist air, with a penetrating odor resembling that of bitter almonds, and a sharp alkaline taste and reaction. Its fumes are poisonous when inhaled, and when taken internally the salt acts as a violent poison. It must be preserved in glass-stoppered bottles.

*Uses.*—Its medicinal properties and uses are similar to those of Hydrocyanic Acid, for which it is sometimes used (in the right proportion) because of being more stable. The commercial article is largely used in the arts for mining, plating, etc., but is usually too impure for medicinal purposes.

# Sodium.

Sodium resembles Potassium, and forms a similar series of compounds.

*Sources.*—Sodium does not occur native, but its compounds are abundant and widely distributed, Common Salt, Chili Saltpetre, Sodium Carbonate and Sodium Sulphate forming considerable deposits in some localities. The Silicates and Fluorides of Sodium are also common minerals.

*Sodium.*—Na.—The symbol is derived from Natrium, the Nitrum of the ancients.

Metallic sodium is obtained by a process analogous to that used for obtaining potassium, but it is obtained with less difficulty than the latter metal.

A white metal with a silvery luster, sp. gr. 0.973, has the consistency of wax at ordinary temperature; when thrown on water forms the hydrate and melts by the heat produced by its union with the oxygen of the water, but the freed hydrogen of the latter is not inflamed unless the melted sodium globule be restrained from moving about: when it burns, and the flame has a deep yellow color. It readily oxidizes in contact with moist air.

*Uses.*—The metal itself is not used in pharmacy, but its compounds are not less important than those of potassium.

## COMPOUNDS OF SODIUM.

The three most common natural Compounds of Sodium are the Chloride, the Sulphate and the Nitrate.

*Sodium Chloride.*—NaCl — Sodii Chloridum, U. S.—This is common “salt,” too familiar to require description. It is found native as Rock Salt in many parts of the world, and occurs in the sea, as well as in many lakes, and in plants and animals.

It is chiefly obtained in the States of New York, Michigan, West Virginia and Kansas from Salt-wells in the Earth, the brine being pumped to the surface and the Salt obtained by evaporation in vacuum apparatus.

*Uses.*—In pharmacy in the preparation of Chlorine gas, Hydrochloric Acid, Calomel, etc., and somewhat also in medicine, in washes and as a haemostatic, etc.

*Sodium Sulphate.*— $\text{Na}_2\text{SO}_4 + 10\text{H}_2\text{O}$ .—Sodii Sulphas, U. S.—Commonly called Glauber’s Salt. Frequently found native, and obtained as a by-product in many chemical processes.

**L**arge, transparent, colorless, monoclinic prisms; which are odorless, with a cooling, saline, and a decidedly bitter taste. Efflorescent and crumbling to a white powder on exposure to dry air, neutral to test paper, soluble in 2.8 parts of water and insoluble in alcohol.

*Uses.*—As a purgative; chiefly in veterinary practice.

*Sodium Nitrate.*— $\text{NaNO}_3$ .—Sodii Nitrás, U. S.—Occurs native in extensive beds in Chili and Peru, and the crude article is called Chili Saltpetre.

Transparent, colorless, deliquescent, rhombohedral crystals. Neutral to test paper, inodorous, taste cooling, saline and bitterish. Soluble in 1.3 parts of water and nearly insoluble in alcohol. Melts at  $312^{\circ}\text{C}.$ , and at higher temperatures gives off oxygen, and is converted into the nitrite.

*Uses.*—Principal source of Nitric Acid, also used in preparing Sodium Arsenate. In medicine, chiefly as a mild purgative.

In the arts as a substitute for Potassium Nitrate or the ordinary East India Saltpetre.

*Sodium Nitrite.*— $\text{NaNO}_2$ .—Sodii Nitris, U. S.—Obtained by heating Sodium Nitrate with some organic substance, such as Starch, or by fusing it with lead, forming Lead Oxide and Sodium Nitrite.

White opaque masses or in the form of pencils, deliquescent and changed to the nitrate by exposure to the air.

Soluble in 1.5 parts of water, very soluble in boiling water, slightly soluble in alcohol.

*Uses.*—To yield Nitric Oxide in the preparation of Spirit Nitrous Ether; sometimes used internally.

*Sodium Carbonate.*— $\text{Na}_2\text{CO}_3 \cdot 10\text{H}_2\text{O}$ .—Sodii Carbonas, U. S.—“Sal Soda;” exists in many mineral waters, the waters of certain lakes in hot and dry countries, and also in plants.

It is manufactured at Natrona, Pa., from the mineral Cryolite obtained from Greenland, which is a double Fluoride of Sodium and Aluminum, by boiling it with caustic Lime.

The Leblanc process consists in heating the Chloride with Lime and Coal and obtaining the carbonate by lixiviation in an impure form known as “Soda Ash.” From this the pure salt is obtained by crystallization.

It is also obtained by the *ammonia process* of Solvay, which consists in treating Sodium Chloride with Ammonia gas and Carbon Dioxide. Ammonium Chloride and Sodium Bicarbonate are formed, the latter precipitating because of its comparative insolubility. The Carbonate is easily obtained by heating the Bicarbonate, dissolving and crystallizing the residue.

Large, colorless, oblique rhombic crystals, or in irregular lumps, with a strongly alkaline reaction and with an alkaline taste. On exposure to the air

it effloresces and falls to a white powder. Insoluble in alcohol, soluble in 1.6 parts of water.

*Uses.*—To prepare various other sodium compounds, only the whole crystal should be used. It is purified by re-crystallization, or granulated for medicinal use.

*Off. Prep.*—Sodii Carbonas Exsiccatus, made by exposing the crystals to the air, and then to a temperature of 45°C., until a white powder is formed, which represents one-half the original weight of the Salt.

*Sodium Bicarbonate.*— $\text{NaHCO}_3$ .—Sodii Bicarbonas, “Baking Soda.”—Made from the Carbonate by exposing it to Carbon Dioxide.

White powder, permanent in air, odorless, cooling, saline taste, and alkaline reaction. Soluble in 11.3 parts of water, insoluble in alcohol. The aqueous solution if heated gives up a part of its carbon dioxide and becomes a solution of the carbonate.

*Uses.*—For the preparation of various other sodium compounds, in medicine as an antacid to furnish Carbonic Acid to draughts and in the manufacture of Baking-Powder.

*Off. Prep.*—Mistura Rhei et Soda; Pulv. Effervescentes comp.; Trochisci Sodii Bicarbonatis.

Sodii Bicarbonas Venalis is common, impure commercial sodium bicarbonate, formerly official.

*Soda.*— $\text{NaHO}$ .—Soda, U. S., “Caustic Soda.”—The process of manufacture is similar to that of potassa, consisting in decomposing a solution of Sodium Carbonate with Lime. The insoluble Calcium Carbonate formed precipitates, and the Sodium Hydrate is obtained upon evaporation of the solution.

Caustic soda closely resembles caustic potassa in appearance and properties, and is usually cast in pencils in the same way. Soluble in 1.7 parts of water, in 0.8 part boiling water and freely soluble in alcohol. It does not produce a precipitate when an aqueous solution of it be dropped into an aqueous solution of tartaric acid, even when the latter remains in excess. It is thus readily distinguished from caustic potassa.

*Uses.*—Similar to potassa.

*Off. Prep.*—Liquor Soda, made either from Sodium Carbonate and Lime, or by dissolving 56 Gm. Caustic Soda in Water to make 1000 Gm. similarly to the process for Solution of Potassa.

*Sodium Chlorate.*— $\text{NaClO}_3$ .—Sodii Chloras, U. S.—Obtained by the action of Chlorine on a solution of Soda, by a process analogous to that for the corresponding salt of potassium.

Transparent, tetrahedral crystals, permanent in the air, odorless, cooling, saline taste, and neutral reaction. Yields up its oxygen when heated, leaving common salt as the residue.

If triturated with organic or other easily oxidizable compounds, explosion is liable to occur and the same precautions must be taken in storing, handling and mixing it as are directed in the case of Potassium Chlorate.

*Uses.*—Similar to those of Potassium Chlorate.

*Sodium Bromide.*—NaBr.—Sodii Bromidum, U. S.—Obtained by double decomposition between Ferrous Bromide and Sodium Carbonate by a process similar to that employed for potassium bromide.

A white crystalline powder or small white monoclinic crystals, permanent in dry air, odorless, having a saline taste, and a neutral or faintly alkaline reaction. Soluble in 1.2 parts of water and in 13 parts of alcohol, and fusing without loss of weight at a dull-red heat.

*Uses.*—Same as those of Potassium Bromide.

*Preparation.*—An unofficial Elixir containing 10 grains to the fluid-dram. (See Nat. Form.)

*Sodium Iodide.*—NaI.—Sodii Iodidum, U. S.—Obtained by the reaction of Iodine on Soda and the conversion of the Iodate into Iodide by the same method employed in making Potassium Iodide.

A white powder or small, colorless or transparent, monoclinic crystals. Deliquescent, inodorous, and having a bitterish saline taste. Soluble in 0.6 part of water and 3 parts of alcohol. Melts at a dull-red heat, and at a higher temperature volatilizes with partial decomposition.

*Uses.*—Same as that of Potassium Iodide.

*Sodium Sulphite.*—Na<sub>2</sub>SO<sub>3</sub>+7H<sub>2</sub>O.—Sodii Sulphis, U. S.—Prepared by neutralizing a solution of Sodium Carbonate with Sulphurous Acid gas.

Transparent, colorless, monoclinic prisms, odorless, with cooling, saline and somewhat sulphurous taste, and slightly alkaline reaction. Effloresces and gradually changes to the sulphate on exposure to the air. Soluble in 4 parts of water and but slightly soluble in alcohol. When heated it first melts, then loses its water of crystallization, and finally is decomposed, giving off sulphurous gas.

*Uses.*—In medicine similar to those of potassium sulphite as an anti-fermentative, etc.

*Sodium Bisulphite.*—NaHSO<sub>3</sub>.—Sodii Bisulphis, U. S.—Made by saturating a cold solution of Sodium Carbonate with Sulphurous Acid gas.

A white granular powder or opaqueprismatic crystals, odor faintly sulphurous, taste disagreeable, undergoing decomposition on exposure to the air. Soluble in 4 parts of water and in 72 parts of alcohol.

*Uses.*—Similar to those of the normal sulphite.

*Sodium Hyposulphite.*—Na<sub>2</sub>S<sub>2</sub>O<sub>3</sub>+5H<sub>2</sub>O.—Sodii Hyposulphis. U. S., Sodium Thiosulphate.—Usually prepared by heating together the proper proportions of Sulphur and dried Sodium Carbonate, stir-

ting vigorously to facilitate oxidation, and then converting the normal Sulphite thus formed into the Hyposulphite by dissolving it in Water and boiling it with Sulphur. It is also prepared by decomposition of Calcium Thiosulphate with Sodium Carbonate, or Sulphate.

**Monoclinic**, prismatic or tabular crystals, permanent in the air, transparent colorless, inodorous, and with a sulphurous, cooling and alkaline taste. Soluble in 0.65 part of water and insoluble in alcohol, decomposed in boiling water. On heating, it first loses its water of crystallization and then is decomposed with the separation of sulphur.

**Uses.**—In medicine, for its anti-putrefactive and anti-fermentative properties, chiefly. In the arts, in the manufacture of paper and in photography as a solvent for bromide, or chloride, of silver.

**Preparations.**—The Volumetric Test Solution and in the so-called Decolorized Tincture of Iodine.

*Tincture Iodi Decolorata.*—Prepared by digesting Iodine and Sodium Hyposulphite in water, until a dark, brownish-red solution results; adding Alcohol and Stronger Water of Ammonia and shaking until the solution has become colorless. (See Nat. Form.)

*Sodium Sulphocarbolate.*— $\text{NaSO}_3\text{C}_6\text{H}_4(\text{OH}) \pm 2\text{H}_2\text{O}$ .—Sodii Sulphocarbolas, U. S. (Sodium Paraphenolsulphonate).—Obtained by the reaction of Barium Sulphocarbolate in solution, upon Sodium Carbonate or Sodium Sulphate.

Rhombic prismatic crystals, which are colorless or slightly pinkish, transparent, permanent in the air, inodorous, with a bitterish, saline taste. Soluble in 4.8 parts of water and in 1.32 parts of alcohol. When heated it first loses its water of crystallization, then decomposes, giving off the odor of carbolic acid, leaving behind a charred mass.

**Uses.**—It has much the same medicinal value as carbolic acid, but is much milder in its action.

*Sodium Phosphate.*— $\text{Na}_2\text{HPO}_4 + 12\text{H}_2\text{O}$ .—Sodii Phosphas, U. S.

Prepared by a somewhat complicated process from Bone-ash, Sulphuric Acid and Sodium Carbonate.

Transparent, colorless, monoclinic, prisms of large size, efflorescent on exposure to the air, inodorous and with a cooling, saline or somewhat alkaline taste, and a slightly alkaline reaction. Soluble in 5.8 parts of water and insoluble in alcohol. When heated to 10° C. the salt fuses, yielding a colorless liquid; at 100° C. it loses its water of crystallization and at 300° C. it is converted into the pyrophosphate.

**Uses.**—For the preparation of the Sodium Pyrophosphate, of Iron Phosphate etc. In medicine mainly for its mildly purgative effects.

*Sodium Pyrophosphate.*— $\text{Na}_4\text{P}_2\text{O}_7 + 10\text{H}_2\text{O}$ .—Sodii Pyrophosفات, U. S.—Prepared by heating the phosphate to 300° C.

Translucent, colorless, monoclinic prisms, permanent in the air, odor and taste like the phosphate, soluble in 12 parts of water and insoluble in alcohol.

*Uses.*—Chiefly for the preparation of Iron Pyrophosphate.

*Sodium Hypophosphite.*— $\text{NaPH}_2\text{O}_2 + \text{H}_2\text{O}$ .—Sodii Hypophosphis, U. S.—Made by the neutral reaction of Sodium Carbonate and Calcium Hypophosphite, and in other ways.

A white powder, or colorless rectangular tabular crystals, very deliquescent, odorless, with a saline, slightly sweetish taste, soluble in 1 part of water and 30 of alcohol. When heated strongly, it first loses its water of crystallization, and then undergoes decomposition.

*Uses.*—In medicine, in treatment of phthisis, bronchitis, and in nervous debility.

*Off. Prep.*—Syrupus Hypophosphitum; Syrupus Hypophosphitum cum Ferro; and in unofficial Cod liver oil Emulsions, Elixirs, etc. [See Nat. Form.]

*Sodium Arsenate.*— $\text{Na}_3\text{HAsO}_4 + 7\text{H}_2\text{O}$ .—Sodii Arsenas, U. S.—Made by fusing together in the proper proportions Sodium Carbonate and Nitrate with Arsenous Acid, treating the fused mass with Water and crystallizing.

Colorless, transparent, prismatic crystals, that are odorless, and have a somewhat alkaline taste. Somewhat deliquescent, soluble in 4 parts of water, very sparingly in alcohol. It is poisonous.

*Uses.*—Similar to those of Fowler's Solution.

*Off. Prep.*—Liquor Sodii Arsenatis.

*Sodium Acetate.*— $\text{NaC}_2\text{H}_3\text{O}_2 + 3\text{H}_2\text{O}$ .—Sodii Acetas, U. S.—Made by saturating a solution of Sodium Carbonate, or Bicarbonate, with Acetic Acid and obtaining the salt by evaporation and crystallization.

Colorless, transparent, monoclinic prisms or a granular crystalline powder, odorless, slightly alkaline, of a bitterish, saline taste and efflorescent in dry air. Soluble in 1/4 parts of water and in 30 parts of alcohol. At 60°C. the crystals melt, at 123°C. give off their water of crystallization, and at a higher temperature the mass blackens and decomposes.

*Uses.*—Similar to those of Potassium Acetate, to which it is sometimes preferred bcc. use of its milder action.

*Sodium Benzoate.*— $\text{NaC}_7\text{H}_5\text{O}_2$ .—Sodii Benzoas, U. S.—Made by neutralizing a solution of Benzoic Acid with Sodium Carbonate, the liquor evaporated and allowed to crystallize, or evaporated to dryness and the salt obtained granulated.

White, semi-crystalline or amorphous powder, usually with a faint odor of benzoin, a sweet, astringent taste, and neutral reaction. It is soluble in 1/8 parts of water and in 45 parts of alcohol.

*Uses.*—In gastritis, dyspepsia and renal disorders.

*Sodium Salicylate.*— $2\text{NaC}_7\text{H}_5\text{O}_3$ .—Sodii Salicylas, U. S.—Prepared by the reaction of Salicylic Acid on Soda, or on Sodium Carbonate, in Water.

White, tabular crystals of small size, or in the form of a white, crystalline powder. Inodorous, saline, and somewhat sweetish taste, and slightly acid reaction. Dissolves in 0.9 part of water and in 6 parts of alcohol. Decomposed by heat, giving off inflammable vapors and leaving a charred mass.

*Uses.*—In medicine, mainly in the treatment of rheumatism. Conveniently prepared extemporaneously in solution from salicylic acid and sodium bicarbonate.

*Sodium Santoninate.*—Made by the reaction of Seda on Santonin, in the presence of Water, and crystallizing the salt was official in the U. S. Ph., 1880,

It was used in the form of troches, but since the Sodium Salt of Santonin has proved to be unreliable as a worm-destroyer the substance and the troches have both been discarded.

### LITHIUM.—Li.

Lithium does not exist free in nature, and its compounds are much less abundant than either those of potassium or sodium. It occurs in certain minerals, as lepidolite, spodumene, petalite, etc.; in certain mineral waters, in minute quantities in sea-waters and even in most fresh waters. It occurs also in many plants.

The metal, which is too expensive to be more than a scientific curiosity, is obtained by electrolysis from the chloride. It bears a close resemblance to potassium and sodium in its properties. It is the lightest of all known metals, having a sp. gr. of only 0.5891.

#### Characteristic Reactions of Lithium Salts:

The compounds are not volatilized at a low red heat.

They impart a beautiful crimson color to a non-luminous flame. A white precipitate is produced in a solution of Lithium Chloride upon boiling with Sodium Phosphate or Carbonate.

The following Compounds of Lithium are official:

*Lithium Carbonate.*— $\text{Li}_2\text{CO}_3$ .—Lithii Carbonas, U. S.—Obtained from the Chloride by treating its solution with Ammonium Carbonate.

A light, white powder, odorless and having an alkaline taste; permanent in the air. Soluble in 80 parts of water, in 140 parts of boiling water; much more soluble in Carbonic Acid Water; insoluble in alcohol.

*Uses.*—In medicine as a solvent for uric acid deposits and gouty concretions; also as a remedy for gouty and rheumatic affections. The dose of the Lithium compounds ranges from 0.3 to 1 Gm. (5 to 15 grs.).

From the Carbonate all the other Lithium compounds are easily made.

*Lithium Bromide.*— $\text{LiBr}$ .—Lithii Bromidum, U. S.—Is made from the Carbonate by decomposing it with Hydrobromic Acid.

A white granular salt, colorless, and having a sharp, slightly bitter taste;

very deliquescent. Soluble in 0.6 part of water and 0.3 part of boiling water; very soluble in alcohol; also soluble in ether.

*Uses.*—It has the same medicinal virtues as the other bromides, only, it is claimed, in a higher degree, because more soluble and containing a larger proportion of bromine.

*Lithium Benzoate.*— $\text{LiC}_7\text{H}_5\text{O}_2$ .—*Lithii Benzoas*, U. S.—Made from the Carbonate by decomposing it with Benzoic Acid.

A light, white powder or small, shining, crystalline scales; odorless or of a faint benzoin-like odor and of a cooling, sweetish taste. Soluble in 4 parts of water and in 12 parts of alcohol.

*Uses.*—To some extent in medicine as a substitute for sodium benzoate.

*Lithium Citrate.*— $\text{Li}_3\text{C}_6\text{H}_5\text{O}_7$ .—*Lithii Citras*, U. S.—Made from the Carbonate by saturating a solution of it with Citric Acid.

A white powder, odorless, and having a cooling, faintly alkaline taste; deliquescent on exposure to air. Soluble in 2 parts of water, almost insoluble in alcohol or ether.

*Uses.*—Similar to those of the carbonate.

*Lithii Citras Effervescent.*—U. S.—A mixture of Lithium Carbonate, 70 Gm.; Citric Acid, 370 Gm.; Sodium Bicarbonate, 280 Gm. and Sugar to make 1000 Gm.

A convenient and elegant form of administering Lithium Salts. The dose is from 4 to 8 Gm.

*Lithium Salicylate.*— $\text{LiC}_7\text{H}_5\text{O}_3$ .—*Lithii Salicylas*, U. S.—Produced by the action of Salicylic Acid upon the Carbonate.

A white or grayish white, deliquescent powder, odorless and having a sweetish taste; very soluble in water or alcohol.

*Uses.*—Similar to those of the corresponding salts of potassium and sodium.

# The Alkaline Earths.

The alkaline earths include the elements Barium, Calcium, Strontium and Magnesium.

## BARIUM.—Ba.

Barium occurs in nature chiefly in the form of Sulphate or *heavy-spar*, and as Carbonate or Witherite. The metal, obtained by electrolysis, possesses a bright, yellow color, and burns brilliantly when heated in the air.

Only one salt of barium is official, but some of the compounds are used in chemistry and in the arts, the chloride as a chemical reagent, the sulphate as a pigment and the nitrate in pyrotechny.

*Barium Dioxide*— $\text{BaO}_2$ .—Barii Dioxidum, U. S.—Barium Peroxide. Prepared by conducting oxygen over Barium Oxide heated to redness.

A heavy, grayish-white, amorphous powder, odorless and tasteless. When exposed to the air, it slowly attracts moisture and carbon dioxide, and is gradually decomposed. It should be kept in well-closed vessels.

Almost insoluble in cold water, with which, however, it forms a definite hydrate, and to which it imparts a decidedly alkaline reaction. Hydrochloric, phosphoric, and most other mineral acids decompose it, producing the corresponding barium salts, and hydrogen dioxide, which remains in solution for a considerable time, if the reaction has taken place in the cold, and an excess of the acid is present. Owing to this property it is used for the preparation of Aqua Hydrogenii Dioxidii, U. S. Ph.

## CALCIUM.—Ca.

Calcium is an abundant metal in nature, being represented by a large number of compounds, several of which, like Limestone or, native Calcium Carbonate and the Sulphate, or "Gypsum," constitute no inconsiderable portion of the earth's crust. The metal itself, although it has been isolated and studied, is rarely used outside the chemical laboratory and for the production of artificial light.

It is obtained by electrolysis, and is a yellow metal harder than lead, malleable, tough, or in some conditions brittle; undergoes oxidation slowly in dry air, rapidly in damp air, and when thrown into water decomposes it with rapid evolution of hydrogen.

*Lime*.— $\text{CaO}$ .—Calx, U. S.—Calcium Oxide. Made by calcining white marble, oyster-shells, or the purest varieties of natural Calcium Carbonate, or Limestone. Carbon dioxide and water are expelled, and Lime or Calcium Oxide remains.

Grayish-white masses, which upon exposure to air gradually attract moisture and carbonic acid gas, and fall into a white powder. When moistened with water the latter is absorbed with the liberation of heat, the lime being hydrated, commonly termed "slaked." Mixed with 3 or 4 times its weight of water, slaked lime forms a uniform, smooth magma called "milk of lime." It is soluble in 750 parts of cold water, much less in boiling water, 1,300 parts. Lime or burnt lime must be protected from moisture and air, and slaked lime should be prepared when wanted.

*Uses.*—For dehydrating various substances, such as alcohol and ether; in the preparation of alkalies and alkaloids and certain organic acids. In preparing Chlorinated Lime, Potassium Chlorate, etc.

*Off. Prep.*—Liquor Calcis, a saturated solution of Lime in Distilled water; Potassa cum Calce, Linimentum Calcis and Syrupus Calcis.

*Sulphurated Lime.*—Calx Sulphurata, U. S.—Commonly misnamed "Calcium Sulphide," is a mixture of sulphide and sulphate of calcium, prepared by fusing together dried Calcium Sulphate, Charcoal and a little Starch.

*Uses.*—As a depilatory, and internally in skin diseases.

#### CALCIUM COMPOUNDS.

*Prepared Chalk.*— $\text{CaCO}_3$ .—Creta Preparata, U. S.—Native Calcium Carbonate freed from most of its impurities by a peculiar process of separation with water, termed *elutriation*.

White, amorphous powder, usually appearing in commerce in the form of small cones or drops.

*Uses.*—Medicinally in many compounds, also largely in Face Powders and Dentifrices.

*Off. Prep.*—Hydrargyrum cum Creta, Pulvis Cretæ Compositus for Mistura Cretæ, and Trochisci Cretæ.

*Calcium Chloride.*— $\text{CaCl}_2$ .—Calcii Chloridum, U. S.—Obtained by the reaction of Hydrochloric Acid on Marble, or other Calcium Carbonates and rendered anhydrous by fusion at the lowest possible temperature.

Hard, white masses, which have a pungent, saline and bitter taste. It is a very deliquescent salt and must be kept in well-stoppered bottles.

*Uses.*—As a valuable test reagent in the pharmaceutical laboratory, for drying certain gases and liquids, and in the preparation of certain Calcium compounds. In medicine also as a resolvent.

*Precipitated Calcium Carbonate.*— $\text{CaCO}_3$ .—Calcii Carbonas Praecipitatus, U. S.—It is produced by the double decomposition of Calcium Chloride and Sodium Carbonate.

Impalpable, white powder, without odor or taste, having a neutral reaction and insoluble in water. At a red heat it gives off carbon dioxide, and is converted into calcium oxide.

*Uses.*—As an astringent and antacid in medicine, and largely as an ingredient in Face Powder and Dentifrices.

*Precipitated Calcium Phosphate.* —  $\text{Ca}_3(\text{PO}_4)_2$ . — Calcii Phosphas Praecipitatus, U. S.—Obtained from a dilute solution of Bone-Ash in Hydrochloric Acid by precipitation with Ammonia. The precipitate is in the form of a light-white powder, which at a red heat fuses, and on cooling forms a hard, porcelain-like mass.

*Uses.*—Formerly in preparing Syrup of Calcium Lactophosphate and in medicine for the same purposes as the hypophosphite; also as a filtering medium.

*Off. Prep.*—Pulvis Antimonialis, and Syrupus Calcii Lactophosphatis, U. S. Ph., '80.

*Calcium Bromide.* —  $\text{CaBr}_2$ . — Calcii Bromidum, U. S.—Made by dissolving Calcium Carbonate in Hydrobromic Acid.

Whitish salt in granules or powder, without odor, and a saline, bitter taste. It deliquesces in the air, is soluble in 0.7 part of water and 1 part of alcohol, melts at a red heat, and at that temperature begins to give off bromine.

*Uses.*—Similar to those of the other bromides.

*Calcium Hypophosphite.* —  $\text{Ca}(\text{PH}_2\text{O}_4)_2$ . — Calcii Hypophosphis, U. S.—Obtained by heating Phosphorus with Milk of Lime.

Thin, colorless transparent and flexible scales, or in white, pearly, lustrous crystalline powder. Neutral, or slightly alkaline, odorless, and of a disagreeably bitter taste. Soluble in 6.8 parts of water, in 6 parts boiling water, insoluble in alcohol.

*Uses.*—In the preparation of Syrup of Hypophosphites and various unofficial Syrups, Elixirs and Emulsions used in the treatment of pulmonary diseases, etc. [See Nat. Form.]

*Off. Prep.*—Syrupus Hypophosphitum.

### STRONTIUM.—Sr.

Strontium occurs in nature as Sulphate and Carbonate, the latter being a mineral found in Scotland termed Strontianit, whence the name of the element is derived. It is also found in small quantities in barytes, gypsum, limestone, sea-water and in some mineral waters.

The metal is obtained from the chloride by electrolysis and is a yellow ductile metal having a sp. gr. of 2.5.

The Salts of Strontium have much the same character as those of Barium. They are all made from the Carbonate or from the Hydroxide which is itself produced by heating the Nitrate, the most common commercial Strontium compound. The Nitrate is largely used in red-fire owing to the bright-red color of its flame, when burned. It is not official.

*Strontium Bromide.* —  $\text{SrBr}_2 + 6\text{H}_2\text{O}$ . — Strontii Bromidum, U. S.—Made by reaction of Hydrobromic Acid on Strontium Carbonate.

Colorless, transparent, hexagonal crystals, odorless and having a saline,

bitter taste, very deliquescent and should be kept in glass-stoppered vials. Soluble in 1 part of water, readily in alcohol and precipitated from its alcoholic solution by ether, in which it is insoluble.

*Uses.*—Similar to other Bromides, in doses from 1 to 2 Gm.

*Strontium Iodide.*— $\text{SrI}_2 + 6\text{H}_2\text{O}$ .—Strontii Iodidum, U. S.—Made by reaction of Hydriodic Acid on Strontium Carbonate.

Colorless, transparent hexagonal plates, odorless and having a bitterish, saline taste. Deliquescent and colored yellow by exposure to air and light and should, therefore, be kept in dark, amber-colored, glass-stoppered vials. Soluble in 0.6 part of water, also in alcohol and slightly in ether.

*Uses.*—Similar to other Iodides, in doses from 0.5 to 1 Gm.

*Strontium Lactate.*— $\text{Sr}(\text{C}_3\text{H}_5\text{O}_3)_2 + 3\text{H}_2\text{O}$ .—Strontii Lactas, U. S.

—Made by reaction of Lactic Acid on Strontium Carbonate.

A white, granular powder, or crystalline nodules, permanent in the air, odorless and having a slightly bitter, saline taste. Soluble in alcohol and in 4 parts of water.

*Uses.*—In affections of the heart and kidneys in doses from 1 to 3 Gm.

### MAGNESIUM.—Mg.

Although an abundant metal, magnesium is not free in nature. It occurs in the minerals, magnesite, dolomite, kieserite, asbestos, talc, soapstone, meerschaum and many others; it occurs as the Sulphate in many saline springs, notably those at Epsom, England; as Chloride in sea-water, and in many salt springs, and it is also found in the bones of animals, and the tissues of many plants.

*Magnesium.*—Mg.—The metal is obtained from its Chloride, or the double Chloride of Magnesium and Potassium, by heating it, together with fluor spar and sodium, in a red-hot iron crucible, and afterward distilling, avoiding contact with the air, when the crude metal is obtained.

Brilliant silver-white metal, soon tarnishing in damp air, sp. gr. 1.75. Melts at a red heat, and may be inflamed, when in the form of rather fine wire or ribbon, by holding it in a candle, when it burns with an intensely active flame, producing a bulky white oxide.

The metal itself is not of pharmaceutical importance, its chief use being to produce a strong dazzling light similar to that of calcium.

The most common compound is the Sulphate and from this all the other medicinal compounds are indirectly produced.

*Magnesium Sulphate.*— $\text{MgSO}_4 \cdot 7\text{H}_2\text{O}$ .—Magnesii Sulphas, U. S.—Commonly known as Epsom Salt. It occurs native, as has already been stated, and is also manufactured from the mineral kieserite, which, aside from its impurities, differs in composition from Epsom salt only in having six molecules less of water of crystallization.

Four-sided rhombic prisms or acicular crystals without odor, taste saline and bitter, freely soluble in water (1.5) and insoluble in alcohol.

*Uses.*—In the preparation of the carbonate, and in medicine as a purgative.  
*Off. Prep.*—Infusum Sennae compositum.

*Magnesium Carbonate.*— $(\text{MgCO}_3)_4 + \text{Mg}(\text{OH})_2 + 5\text{H}_2\text{O}$ .—Magnesii Carbonas, U. S.—It will be seen from the formula that the official carbonate is really a mixture of the Carbonate and Hydroxide. It is made by the reaction in solution of Sodium Carbonate and Magnesium Sulphate.

A very light white powder or friable masses, nearly insoluble in both alcohol and water, but giving to the latter a slight alkaline reaction. Dissolves with effervescence in hydrochloric acid.

*Uses.*—For the preparation of Magnesia, Liquor Magnesia-Citratis and other compounds, and in medicine for similar purposes as magnesia; also as a Face Powder.

*Magnesii Citras Effervescentis*, U. S.—A granular powder obtained by mixing Magnesium Carbonate, Citric Acid, Sodium Bicarbonate, Sugar and Water and Alcohol, drying the mixture and reducing it to a very coarse powder.

*Uses.*—To furnish effervescent purgative draughts.

*Magnesia.*— $\text{MgO}$ .—Magnesia, U. S.—Magnesium Oxide.—Calcin'd, or "Light" Magnesia. Obtained by igniting (calcining) the Carbonate.

A very white and light powder, which on exposure to the air slowly absorbs carbon dioxide and becomes converted into the carbonate. It should therefore be kept in tightly-stoppered bottles.

*Uses.*—In medicine chiefly as a corrective to acidity in the alimentary tract.

*Off. Prep.*—Ferri Oxidum Hydratum cum Magnesia; Pulvis Rhei compositus.

*Heavy Magnesia.*—Magnesia Ponderosa, U. S., is similar to the above, except in possessing only one-fourth the bulk, which facilitates its administration.

It is prepared by calcining the heavy Carbonate; the latter is produced in the same way as the ordinary carbonate, except that the Murexian Sulphate and Sodium Carbonate are used in hot, concentrated solutions.

*Magnesium Sulphite.*— $\text{MgSO}_4 \cdot 6\text{H}_2\text{O}$ .—Magnesii Sulphis.—Made by the reaction of Sulphurous Acid on Magnesia or Magnesium Carbonate. Not official.

White, crystalline, colorless and bitterish powder, with a sulphurous taste; changes to the sulphate gradually on exposure to the air, and hence should be kept in tightly-stoppered bottles.

*Uses.*—Similar to those of sodium sulphite.

# The Aluminum Group.

This group includes the elements Aluminum, Cerium and Chromium.

## ALUMINUM.—Al.

This metal does not exist free in nature, although, with the exception of oxygen and silicon, it is the most abundant and widely distributed of the elements.

It occurs as the oxide in Corundum, of which emery, ruby and sapphire are varieties; in the minerals, cryolite, bauxite and diaspore; in the different kinds of Feldspars, which make up a considerable portion of the weight of granite, syenite, gneiss, mica, porphyry, and so on; in kaolin and the clays, which are essentially Silicates of aluminum. The metal is, therefore, contained in abundance in all fertile soils.

The metal is produced from its ores by reducing these with Carbon and the intense heat produced by an electric furnace.

*Aluminum*.—Al.—A tin-white, very sonorous metal, capable of receiving a high polish, very malleable, ductile, and tough, sp. gr. from 2.56 to 2.67, conducts electricity eight times better than iron, oxidizes but little, and produces, with copper and other metals, a series of alloys, some of which have exceedingly valuable properties.

The metal free from arsenic is used for testing purposes in the form of foil, wire or ribbon. It undergoes slight oxidation upon exposure, but the oxide is of the same color as the metal and articles made from aluminum do not, therefore, become discolored, or rust, as is the case with iron, copper, etc. Aluminum vessels should not be used for strong alkalies as the metal is easily affected by alkaline hydrates.

## COMPOUNDS OF ALUMINUM.

*Ahom*.— $K_2Al_2(SO_4)_4 + 24H_2O$ .—Alumen, U. S.—Potassium Alum.—The double Sulphate of Aluminum and Potassium. Obtained by digesting calcined Clay with Sulphuric Acid, and afterward adding, to the solution of Aluminum Sulphate thus obtained, the proper proportion of Potassium Sulphate, and crystallizing.

*Ammonia alum* is produced by adding Ammonium Sulphate instead of potassium sulphate.

Transparent, colorless, inodorous crystals of large size, which are octahedra, or octahedra combined with cubes, having a very astringent and somewhat acid taste, and an acid reaction. Effloresces somewhat on exposure to air, dissolves

in 9 parts of water, in 0.3 part boiling water, freely soluble in warm glycerin, but is insoluble in alcohol. Fuses at 92°C. in its water of crystallization, and again solidifies at a higher temperature; when the water has evaporated the porous mass remaining has lost nearly one-half (45 per cent) of its original weight and constitutes the "dried" or "burnt alum," Alumen Exsiccatum, U. S.

*Uses.*—In pharmacy, for the preparation of other compounds of aluminum, as a precipitant and in the *purification* of Water by precipitation (when care should be observed that the Ammonia Alum be not employed). In medicine, on account of its acid and astringent properties, and in the powdered form as an emetic.

*Off. Prep.*—Alumen Exsiccatum.

*Aluminum Hydrate.*— $\text{Al}_2(\text{HO})_6$ .—Alumini Hydras, U. S.—Occasionally found native, but usually prepared from Alum by precipitating it with Sodium Carbonate in hot solution.

Amorphous, white, odorless and tasteless powder insoluble in water or alcohol. At a red-heat loses water, and is converted into the oxide.

*Uses.*—In medicine, as an antacid, and as a protective to the mucous membranes; and, in pharmacy, for preparing the Sulphate.

*Aluminum Sulphate.*— $\text{Al}_2(\text{SO}_4)_3 + 16\text{H}_2\text{O}$ .—Alumini Sulphas, U. S.—For medicinal use, prepared from Aluminum Hydrate by treating it with dilute Sulphuric Acid.

Sometimes in thin pearly lamellæ, but usually in a white, crystalline powder, inodorous, taste sweetish and astringent, and acid to test paper. It is permanent in the air, soluble at 15°C. in 1.2 parts of water, and nearly insoluble in alcohol, loses its water of crystallization at about 200°C. and at a red-heat is decomposed, being converted into oxide.

*Uses.*—In medicine, largely as a caustic in the treatment of chronically inflamed surfaces, exuberant growths, etc.

CERIUM—Ce.

The only compound of this metal of pharmaceutical importance is:

*Cerium Oxalate.*— $\text{Ce}_2(\text{C}_2\text{O}_4)_3 + 9\text{H}_2\text{O}$ .—Cerii Oxalas, U. S.—Prepared from Cerium Chloride by precipitation with Oxalic Acid. The chloride is obtained by the treatment of the mineral gadolenite or cerite in which form the metal is usually found.

The salt is insoluble in both alcohol and water, but soluble in hydrochloric acid.

*Uses.*—In the powdered form, or as an effervescent granular salt, in nervous affections.

## CHROMIUM.—Cr.

This element does not occur free in nature but as the mineral Chromite, or Chrom-iron ore,  $\text{Cr}_2\text{O}_3 \cdot \text{FeO}$ , from which Potassium Bichromate, the Oxide and the metal are obtained. Potassium Bichromate, the most common compound of Chromium, was described under Potassium.

*Chromic Acid.*— $\text{CrO}_3$ .—Acidum Chromicum, U. S.—Chromic trioxide or anhydride.—The official title is incorrect as this compound is a trioxide, or anhydride, and does not form an acid until dissolved in water:  $\text{CrO}_3 + \text{H}_2\text{O} = \text{H}_2\text{CrO}_4$ , as is also the case with “Arsenous Acid.”

It is obtained by adding to a saturated solution of Potassium Bichromate Sulphuric Acid; the anhydride crystallizing out on cooling.

Delicate crimson, needle-like crystals, or strongly lustrous, scarlet, rhombic prisms; strongly deliquescent in moist air, without odor, and intensely caustic when brought in contact with animal tissues. It is highly soluble in water, forming a deep orange-red solution. If strong alcohol be dropped on the crystals, chemical change takes place with incandescence, the anhydride being reduced to the green sesqui-oxide of chromium. The crystals fuse at  $193^\circ\text{C}$ . to a deep-red liquid, and if the temperature be raised to  $250^\circ\text{C}$ ., decomposition occurs, and the anhydride is reduced to  $\text{Cr}_2\text{O}_3$ , with the evolution of oxygen.

*Precautions in handling.*—By mixing chromic anhydride with alcohol, ether, glycerin, cork, tannin, sugar, or other readily oxidizable substances, rapid combustion, or even explosion, may be produced. Owing to its strong affinity for water it must be kept in tightly stoppered bottles.

*Uses.*—In medicine, chiefly as caustic; in microscopy, for hardening tissues

# The Iron Group.

The Iron Group includes the elements Zinc, Manganese, Iron, Nickel and Cobalt

## ZINC.—Zn.

Zinc is a rather abundant metal, though rarely occurring uncombined in nature. Its most important ores are Calamine, or impure Carbonate, zinc blende, franklinite and hydrozincite and they are often found associated with lead ores.

The ores are first roasted to expel sulphur and other impurities, and the oxide thus obtained is heated with charcoal in a suitable furnace. The zinc is distilled over and condensed.

*Zincum.*—Zn.—A bluish-white metal, which melts at 433° C., is brittle at ordinary temperatures, but between 100° C. and 150° is quite malleable and ductile. Its sp. gr. is 6.9. When strongly heated in the air, it burns with a bluish flame, and is converted into the oxide.

Pure Zinc is used in pharmaceutical operations in the production of hydrogen gas and for testing. It should be free from arsenic. [See U. S. Ph.]

## COMPOUNDS OF ZINC.

These are produced by the action of Acids on the Metal or from the Carbonate or Oxide, prepared from the impure Carbonate.

*Zinc Chlorid.*— $\text{ZnCl}_2$ .—Zinci Chloridum, U. S.—It is produced when pure Zinc is acted upon by pure dilute Hydrochloric Acid.

Pure zinc being expensive, in practice ordinary granulated zinc is used, and the iron and other impurities removed by treating the solution with Nitric Acid, evaporating it and heating the dry residue to fusion, to expel the nitric acid, then allowing the mass to cool. The solution thus obtained is treated with Water agitated with Zinc Carbonate, then filtered, and the filtrate evaporated in a porcelain dish, until a drop withdrawn on the end of a glass rod solidifies on cooling to an opaque white solid.

*Liquor Zinci Chloridi*, U. S., prepared in this way, except that the last filtrate is not evaporated, but is diluted with water, has the sp. gr. 1.535, and contains about 50 per cent of the dry chloride.

*Uses.*—Valuable as a deodorizer and disinfectant, and in injections and washes. As it is very irritant, and in large doses poisonous, it must be used with great care.

*Zinc Sulphate.*— $\text{ZnSO}_4 + 7\text{H}_2\text{O}$ .—Zinci Sulphas, U. S.—Obtained by treating Zinc with Dilute Sulphuric Acid. This is commonly called “White Vitriol.”

Large, transparent, rhombic prisms, or in small prisms or prismatic needles,

inodorous, taste styptic nauseous, acid to test paper, soluble in 0.6 part of water and in 3 parts of glycerin, insoluble in alcohol.

*Uses.*—Externally for its stimulant and astringent properties, for the preparation of injections, washes, collyria, etc.; internally in nervous diseases; as a prompt emetic in doses of 10 grains. In large doses poisonous. Also in the preparation of dry Zinc Oleate by chemical decomposition, and many other compounds.

*Precipitated Zinc Carbonate.*— $(\text{ZnCO}_3)_{2/3}\text{Zn}(\text{HO})_2$ .—Zinci Carbonas Praecipitatus, U. S.—Made by double decomposition of solutions of Zinc Sulphate and Sodium Carbonate, in the proper proportions. Not a true Carbonate.

An impalpable, white powder, inodorous, tasteless, permanent in the air, and insoluble in water or alcohol, but soluble in the mineral acids with the evolution of carbon dioxide.

*Uses.*—Externally as an astringent and protective to inflamed surfaces.

*Preparations.*—Unguentum Zinci Carbonatis, an ointment formerly official.

*Zinc Oxide.*— $\text{ZnO}$ .—Zinci Oxidum, U. S.—Made by exposing the Carbonate for some time to a dull red heat, or until a portion of it no longer effervesces with acids (calcination).

Nearly white or slightly yellowish, amorphous, inodorous, tasteless powder, which on heating acquires a lemon-yellow color.

*Uses.*—Rarely internally, but largely as a Dusting Powder for raw and inflamed surfaces; also in the form of ointment.

*Off. Prep.*—Unguentum Zinci Oxidi, also made with petrolatum, which in this case is superior to benzoated lard as a vehicle.

*Zinc Bromide.*— $\text{ZnBr}_2$ .—Zinci Bromidum, U. S.—Conveniently prepared by treating granulated Zinc with Hydrobromic Acid.

White, granular, very deliquescent powder, with a sharp saline and metallic taste, readily soluble in water and alcohol. Rarely used in pharmacy or in medicine.

*Zinc Iodide.*— $\text{ZnI}_2$ .—Zinci Iodidum, U. S.—May be made either by the direct action of Iodine on Zinc in the presence of water, or by that of Hydriodic Acid on the Oxide or Carbonate.

White, granular, crystalline and very deliquescent powder, which is inodorous, with a caustic, metallic taste, and an acid reaction, readily soluble in water, alcohol or ether. When heated with strong sulphuric acid decomposition takes place, and iodine and sulphurous oxide are liberated.

*Uses.*—Sometimes internally, but more commonly as an external application as a wash for scrofulous sores, etc.

*Zinc Phosphide.*— $\text{Zn}_3\text{P}_2$ .—Zinci Phosphidum, U. S.—Obtained by fusing Zinc in a crucible, and adding the requisite amount of Phosphorus a little at a time.

Gray, crystalline, friable mass, emitting a slight odor of phosphorus, undergoes very slow change in the air, and at a high temperature absorbs oxygen from the air, and is converted into the phosphate. It is insoluble in water or alcohol.

*Uses.*—In the pill-form in doses of 1 cg. for nervous disorders.

*Zinc Acetate.*— $\text{Zn}(\text{C}_2\text{H}_3\text{O}_2)_2 + 2\text{H}_2\text{O}$ .—Zinci Acetas, U. S.—Obtained by the reaction of Acetic Acid on Zinc Oxide, or Carbonate.

Thin, white, pearly, six-sided tables or scales, having a faint acetous odor, sharp, metallic taste, and slightly acid reaction. Soluble in 2.7 parts water and 36 parts alcohol, at 15°C.

*Uses.*—Valuable as an irritant and astringent. Seldom used internally.

*Zinc Valerianate.*— $\text{Zn}(\text{C}_5\text{H}_9\text{O}_2)_2 + 2\text{H}_2\text{O}$ .—Zinci Valerianas, U. S.—Obtained by the double decomposition of Sodium Valerianate and Zinc Sulphate when solutions of the two are mixed.

Soft, white scales of a pearly luster, faint odor of valerian; sweet, and afterward styptic, metallic taste; soluble in 100 parts of water and 40 parts of alcohol at 15°C.; and when heated, first melts and afterward decomposes, leaving zinc oxide.

*Uses.*—Chiefly in the pill-form, in doses of one grain, in nervous affections.

#### MANGANESE — Mn.

This element, belonging to the iron group of metals, although represented in a number of common ores, pyrolusite (the dioxide), braunite, hausmanite, manganite, and several others, is not nearly so abundant in nature as iron. It is not found in nature in the metallic form, but the metal is extracted from its ores with some difficulty.

#### COMPOUNDS OF MANGANESE.

*Manganese Dioxide.*— $\text{MnO}_2$ .—Mangani Dioxidum, U. S.—Mangani Oxidum Nigrum, U. S. Ph., '80.—Black Oxide of Manganese. A native mineral containing at least 66 per cent of the pure Dioxide.

A heavy, dull black, inodorous, tasteless powder, which is insoluble in water and alcohol. Used as a source of Oxygen; in the manufacture of Chlorine gas, etc.

*Manganese Sulphate.*— $\text{MnSO}_4 + 4\text{H}_2\text{O}$ .—Mangani Sulphas, U. S.—Made by the reaction of Sulphuric Acid on the Dioxide.

Transparent, colorless or pale rose-colored crystals, belonging to the right rhombic system. Inodorous, taste bitterish and astringent, slightly efflorescent, soluble in 0.7 parts of water at 15°C., but insoluble in alcohol. Reaction slightly acid.

*Use.*—Occasionally as a tonic in doses of 0.5 to 1 Gm.

# Iron and its Compounds.

## IRON.—Fe.

This well-known metal exists native only in meteoric stones, but its Oxides and Carbonates are very abundant, as are also many other of its compounds. The Oxides, which constitute the principal source of the metal, are reduced by carbon at a high temperature, and on this principle depends chiefly the process of "smelting" and extracting iron from its ores.

The metal is too familiar a commodity to need particular description here. Iron and its compounds are valuable in medicine for their tonic effects, deepening the color of the red corpuscles, and, it is supposed, increasing their number.

The metal itself is official in two forms:

*Iron*.—Ferrum, U. S.—In the form of fine, bright, non-elastic wire. It is used in making many of the preparations of iron. The other is

*Reduced Iron*.—Ferrum Reductum, U. S.—Made by heating the Hydrated Peroxide to redness in an iron tube, and passing a stream of Hydrogen through it. From the process of its preparation also called "Iron by Hydrogen" and *Quevenne's Iron*, after the name of its discoverer.

It is a fine, grayish-black, lusterless powder, attracted by the magnet, without odor or taste, insoluble in water or alcohol, and, when ignited in the air, is converted into ferric oxide.

## COMPOUNDS OF IRON.

Iron forms two classes of compounds, viz: *Ferrous* and *ferric* compounds, the element in the former being *bivalent*, in the ferric *trivalent*. In the latter class of compounds the iron is probably present as a double atom; for example, the ferrous chloride,  $\text{FeCl}_2$ , forms a ferric compound of the composition  $\text{Fe}_2\text{Cl}_6$ , instead of  $\text{FeCl}_3$ .

Chemically the two kinds of salts are distinguished as follows:

The *ferrous* salts all have a greenish color and are easily changed to the higher ferric salts through oxidation by exposure to the air and moisture. The alkalies precipitate, from solutions of *ferrous* salts, Ferrous Hydrate,  $\text{Fe}(\text{OH})_2$ , which through absorption of oxygen loses its greenish-white color and becomes greenish-black then reddish-brown, forming the Ferric Hydrate,  $\text{Fe}_2(\text{OH})_6$ . From *ferric* salts the alkalies precipitate the reddish-brown Ferric Hydrate,  $\text{Fe}_2(\text{OH})_6$ .

Ferrous salts produce with Potassium Ferrocyanide a dark-blue precipitate

"Turnbull's blue." Ferric salts produce a deep-blue precipitate of "Prussian blue."

The two kinds of salts are best distinguished by Potassium Ferricyanide, which produces in *Ferrous* Salts, in dilute solution, a bluish-white coloration rapidly changing to a dark-blue precipitate; with *Ferric* salts no precipitation is produced, but a deepened brown color without any green or greenish-blue tinge.

The two classes of compounds are not distinguished in their official Latin titles, all having the same term, *Ferrum*, genitive *Ferri*, but in the English titles the distinction is made between the *ferrous* and *ferric* compounds, except in the case of the double scale-salts.

From the metal by direct action of the Acids and Halogens the Chloride, Iodide and Cyanphate are made and from these in turn all the other Compounds and Preparations of Iron.

*Ferric Chloride*.— $\text{Fe}_2\text{Cl}_6 + 12\text{H}_2\text{O}$ .—Ferri Chloridum, U. S.—Made by the reaction of Hydrochloric Acid on Iron and oxidizing the ferrous chloride so formed into ferric chloride with Nitric Acid. The complete oxidation of the ferrous compound is determined by testing, excess of Nitric Acid removed by heating and the salt allowed to crystallize.

An orange yellow, very deliquescent salt, usually in irregular masses of a crystalline fracture, often with a faint odor of hydrochloric acid, a styptic taste, and an acid reaction.

*Liquor Ferri Chloridi*, U. S.—Is prepared in the same way. It contains of the anhydrous chloride 37.8 per cent in solution of Water, sp. gr. 1.387, with 5 per cent Hydrochloric Acid.

*Tinctura Ferri Chloridi*, U. S.—Contains 25 C.C. of the solution and 75 C. C. alcohol.

*Liquor Ferri et Ammonii Acetatis*, U. S.—Is prepared from the tincture chloride of iron 2 parts, solution ammon. acet. 20 p., dil. acetic acid 3 p., elixir, glycerin and water of each to make 100 parts by measure.

*Ferric Hypophosphite*.— $\text{Fe}_2(\text{PH}_2\text{O}_2)_6$ .—Ferri Hypophosphis, U. S.—Obtained by the double decomposition of Sodium Hypophosphite and Ferric Chloride in aqueous solution.

Grayish or whitish, inodorous, nearly tasteless powder, permanent in the air, but slightly soluble in water, and freely so in hydrochloric acid.

*Uses*.—In the preparation of unofficial Syrups of Hypophosphites.

*Iodide of Iron*.— $\text{FeI}_2$ .—Ferri Iodidum.—Ferrous Iodide. —Made by the reaction of Iodine upon Iron in the presence of Water until the mixture has lost the odor of iodine and acquired a green color, when it contains ferrous iodide in solution which may be obtained by crystallization.

*Ferri Iodidum Saccharatum*, U. S.—Is prepared by filtering the solution of Ferrous Iodide into Milk Sugar and evaporating to dryness. It should contain 20 per cent of the iodide.

*Properties.*—A yellowish or grayish, very hygroscopic powder, with a sweetish and slightly ferruginous taste. Soluble in 7 parts of water.

*Syrupus Ferri Iodidi*, U. S.—Prepared by filtering the Solution of Ferrous Iodide into hot Syrup in such proportion that it contains 10 per cent by weight of ferrous iodide.

Both of these preparations must be kept in tightly-stoppered vials.

*Ferrous Sulphate*.— $\text{FeSO}_4 + 7\text{H}_2\text{O}$ .—*Ferri Sulphas*, U. S.—This is the familiar "Green Vitriol," or "Copperas," made by the action of Sulphuric Acid on Iron.

Large, pale bluish-green, efflorescent crystals, in the form of monoclinic prisms, inodorous, with a styptic saline taste and reaction. Soluble in 1.8 parts of water at 15°C., insoluble in alcohol. Ordinary impure ferrous sulphate is commonly called "copperas."

*Ferri Sulphas Exsiccatus*, U. S.—Dried Ferrous Sulphate.—Obtained by heating the Sulphate when it loses its water of crystallization and forms a greenish-white powder representing 65 per cent of the weight of the original salt.

*Uses.*—As an ingredient in Pil. Aloes et Ferri, other unofficial pills and in veterinary practice. In large doses poisonous.

*Ferri Sulphas Granulatus*, U. S.—Granulated, or "Precipitated," Ferrous Sulphate.—Prepared by pouring a concentrated aqueous solution of the Sulphate into Alcohol. The salt is thrown out as a pale bluish-green crystalline powder which responds to all the tests for the ordinary sulphate.

*Ferrous Carbonate*.— $\text{FeCO}_3$ .—*Ferri Carbonas*.—Obtained by decomposing Ferrous Sulphate with an alkaline Carbonate or Bicarbonate.

Occurs as a white precipitate rapidly changing into the ferric compound and assuming a dark color, upon exposure to the air. Preserved by Sugar added in its moist state, it is official in the following preparations:

*Ferri Carbonas Saccharatus*, U. S.—A saccharine powder containing 15 per cent.

*Massa Ferri Carbonatis*, U. S.—Vallet's Mass.—A pill mass containing about 35 per cent.

*Mistura Ferri Composita*, U. S.—Griffith's Mixture.—A saccharine liquid containing about 2 per cent.

*Pilulae Ferri Carbonatis*, U. S.—Blaud's Pill.—Each pill containing about 0.06 of ferrous carbonate.

*Ferrous Sulphide*.— $\text{FeS}$ .—Though not official, is important as being the usual source of Sulphured Hydrogen. It is made by the direct union of Iron and Sulphur at a high temperature.

*Ferric Ammonium Sulphate*.— $\text{Fe}_2(\text{NH}_4)_2(\text{SO}_4)_4 + 24\text{H}_2\text{O}$ .—*Ferri et Ammonii Sulphas*, U. S.—Ammonio-Ferric Alum.—Made by dissolving Ammonium Sulphate in a hot solution of Tersulphate of Iron and crystallizing.

Transparent octahedral crystals of an amethyst or violet color, efflorescent, inodorous, and of an astringent taste. Soluble in 3 parts of water, insoluble in alcohol.

Used in medicine for its astringent properties.

From Ferrous Sulphate two official Solutions are prepared by oxidizing the Sulphate with Nitric Acid in the presence of Sulphuric Acid.

*Liquor Ferri Subsulphatis*, U. S.—Solution Persulphate of Iron.—Monsell's Solution, containing about 43 per cent of basic ferric sulphate, sp. gr. 1.550.

*Liquor Ferri Tersulphatis*, U. S.—Solution of Ferric Sulphate, containing 28.7 per cent of the salt, sp. gr. 1.320.

From the Solution of Ferric Tersulphate the Ferric Hydrate is prepared and from this, by reaction and solution with their respective acids, the Acetates, Citrates, Phosphates and Tartrates are produced.

*Ferric Hydrate*.— $\text{Fe}_2(\text{HO})_6$ .—Ferri Oxidum Hydratum, U. S.—Made by precipitating a solution of Ferric Sulphate (tersulphate of iron) with Ammonia Water and thoroughly washing the precipitate. This, in its freshly prepared state, is the best antidote to arsenical poisoning, and the materials for preparing it should always be kept on hand. [See U. S. Ph.]

*Off. Prep.*.—Emplastrum Ferri; Trochisci Ferri.

*Ferri Oxidum Hydratum cum Magnesia*, U. S.—Arsenic antidote. Is prepared from the Tersulphate Solution by converting the iron into the Hydrate by the use of Magnesia.

*Ferric Acetate*.—Obtained by reaction of Glacial Acetic Acid on Ferric Hydrate. Is official only in the following solutions:

*Liquor Ferri Acetatis*, U. S.—This contains 31 per cent of the acetate, sp. gr. 1.160. It should be kept in well-stoppered bottles, away from the light.

*Tinctura Ferri Acetatis*, formerly official, is made of the solution, 50 parts, alcohol 30 parts, acetic ether 20 parts by measure.

*Liquor Ferri Citratis*, U. S.—Made by the reaction of Citric Acid on Ferric Hydrate and evaporating the solution so as to have a sp. gr. of 1.250, when it contains about 35 per cent of the anhydrous salt.

*Ferric Citrate*.— $\text{Fe}_2(\text{C}_6\text{H}_5\text{O}_7)_2 + 6\text{H}_2\text{O}$ .—Ferri Citras, U. S.—Made by evaporating the solution at a temperature not higher than 60°C. until reduced to the consistence of syrup, and then spreading it on glass plates to dry.

Transparent, garnet-red scales, permanent in the air, odorless, having a very faint, ferruginous taste, and an acid reaction. Slowly but completely soluble in water, insoluble in alcohol.

*Iron and Ammonium Citrate*.—Ferri et Ammonii Citras, U. S.—Made by mixing 10 parts of the above solution with 4 parts of Ammonia Water, evaporating at a temperature not above 60°C., until it

has been reduced to a syrupy consistence, then spreading it on glass plates, and drying.

In the form of deliquescent, garnet-red scales, which must be kept in the dark, or in closely-stoppered bottles.

From this salt the following are made:

*Ferri et Strychninae Citras*, U. S.—Contains 1 per cent of Strychnine and 99 per cent of the Citrate of Iron and Ammonium, and is in the form of garnet-red deliquescent scales.

*Vinum Ferri Citratis*, U. S.—Contains 4 per cent of Citrate of Iron and Ammonium.

*Iron and Quinine Citrate*.—*Ferri et Quininæ Citras*, U. S.—Made by evaporating a solution containing 85 parts of Ferric Citrate, 12 parts of Quinine and 3 parts of Citric Acid, at a temperature not exceeding 60°C., until it reaches the consistence of syrup, then spreading it on plates of glass and drying.

Transparent, yellowish-brown or reddish-brown scales, that are somewhat deliquescent, inodorous, and with a bitter, somewhat ferruginous taste. Must be kept in well-stoppered bottles in a dark place. Slowly but completely soluble in cold water, more readily soluble in hot water, and but partially soluble in alcohol.

*Soluble Iron and Quinine Citrate*.—*Ferri et Quininæ Citras Solubilis*, U. S.—Made in the same way and of the proportions of the preceding salt, except that Ammonia Water is added to form Ammonium Citrate with the Citric Acid, which increases the solubility of the Quinine Citrate.

Thin, transparent scales of a greenish, golden-yellow color, rapidly and completely soluble in cold water, but only partially soluble in alcohol.

*Vinum Ferri Amarum*, U. S.—Contains 5 per cent of the Soluble Citrate of Iron and Quinine.

*Soluble Ferric Phosphate*.—*Ferri Phosphas Solubilis*, U. S.—Obtained by treating Citrate of Iron in solution, with Sodium Phosphate in proper proportions, evaporating the solution at a temperature not exceeding 60°C., until it reaches a syrupy consistence, and drying it on glass plates.

Transparent, bright-green scales, not deliquescent, turning dark on exposure to light and should, therefore, be kept in dark well-stoppered bottles, inodorous, having a somewhat acid taste and reaction, freely soluble in water, and insoluble in alcohol.

*Off. Prep.*.—*Syrupus Ferri, Quininæ et Strychninæ Phosphatum*, and a similar unofficial Elixir, N. F.

*Soluble Ferric Pyrophosphate*.—*Ferri Pyrophosphas Solubilis*, U. S.—Prepared in the same way as the last named salt, except that Sodium Pyrophosphate is used instead of the phosphate.

Resembles the phosphate very closely in its properties, but differs in producing a white precipitate instead of a yellow one with solution of silver nitrate.

*Uses.*—Chiefly in Elixirs, in combination with Cinchona or its alkaloids.

*Iron and Ammonium Tartrate.*— $2(\text{FeO})\text{NH}_4\text{C}_4\text{H}_4\text{O}_6 + 5\text{H}_2\text{O}$ .—Ferri et Ammonii Tartras, U. S.—Made by dissolving Ferric Hydrate in a solution of Acid Ammonium Tartrate, until the solution is saturated, then evaporating the solution at a temperature not higher than  $60^\circ$ , and, when it reaches the consistence of syrup, spreading it on glass plates to dry.

Yellowish-brown, or red, transparent scales, neutral to test paper, inodorous, sweetish and slightly ferruginous to the taste, and only slightly deliquescent. Soluble in water, but almost insoluble in alcohol and ether. Should be kept in well-stoppered bottles in a dark place.

*Iron and Potassium Tartrate.*—Ferri et Potassii Tartras, U. S.

The process of manufacture is analogous to that of the preparation just described, Potassium Bitartrate being used instead of ammonium bitartrate; the salts also resemble each other in their properties and uses.

*Ferrous Oxalate.*— $\text{FeC}_2\text{O}_4 + \text{H}_2\text{O}$ .—Ferri Oxalas. Not official.—Obtained by treating a solution of Ferrous Sulphate with the proper proportion of Oxalic Acid.

A yellowish, crystalline precipitate, inodorous and nearly tasteless, permanent in the air, but slightly soluble in water, at  $155^\circ\text{C}$ . loses its water of crystallization, and at a higher temperature is decomposed, leaving ferric oxide.

*Ferric Valerianate.*—Ferri Valerianas, U. S.—Made by adding to a cold solution of either Ferric Chloride or Ferric Sulphate a cold solution of Sodium Valerianate so long as a precipitate is produced.

A brick-red, amorphous powder with a slight odor and taste of valerianic acid. It is decomposed by boiling water, leaving ferric hydrate.

*Uses.*—Similar to other valerianates; dose 0.1 Gm.

*Ferrous Lactate.*— $\text{Fe}(\text{C}_3\text{H}_5\text{O}_3)_2 + 3\text{H}_2\text{O}$ .—Ferri Lactas, U. S.—Made by the direct action of Lactic Acid on Iron.

Greenish-white, crystalline crusts or grains, not deliquescent, inodorous, with a sweetish, ferruginous taste and a slightly acid reaction. Slowly but completely soluble in 40 parts of water, in 12 parts of boiling water; almost insoluble in alcohol.

*Uses.*—In the preparation of Syrupus Hypophosphitum cum Ferro, U. S., consisting of 1 part of the above Lactate with 99 parts of Syrup of Hypophosphites.

# Lead.—Copper.—Tin.

## LEAD.—Pb.

Lead is sometimes, but not often, found free in nature, but its ores are rather abundant, the most important being the Sulphide (galena) and the Carbonate (cerussite.)

There are a variety of ways of obtaining it, depending on the character and purity of the ores. From a pure form of galena it is obtained by roasting it in a reverberating furnace, when a part of the ore is reduced and a part converted into the sulphate, and then, by afterward raising the temperature, the sulphate is also decomposed. In inferior ores carbon is used in the process.

*Plumbum.*—Pb.—A soft metal, with a metallic lustre and a blue-gray color; very ductile and malleable, but not very tenacious; quite soft; sp. gr. 11.4; melts at 325°C., and volatilizes at a white heat. The metal itself is not of importance in pharmacy.

The soluble compounds of Lead are all *poisonous*, the best antidote being Magnesium Sulphate 15 Gm. dissolved in a glassful of water. Vomiting should be promoted by hot water or mustard and milk or demulcent drinks should be administered to allay irritation.

*Lead Oxide.*—PbO.—*Plumbi Oxidum*, U. S.—*Litharge*.—Can be made by heating metallic Lead strongly in Air, but is chiefly obtained as a by-product in the extraction of silver from its ore.

A heavy powder, varying in color from yellowish to reddish, permanent in air, odorless, tasteless, insoluble in water and alcohol, and by means of the blow-pipe and charcoal, readily reducible to metallic lead.

*Uses.*—In pharmacy, for preparing Lead plaster and various Salts of lead.

*Off. Prep.*—Liquor Plumbi Subacetatis; Emplastrum Plumbi.

*Red Lead* is a mixture of different oxides of lead, is of a bright-red color and should not be confounded with the above.

*Lead Acetate.*— $Pb(C_2H_3O_2)_2 + 3H_2O$ .—*Plumbi Acetas*, U. S.—

*Sugar of Lead*.—Obtained by treating the Oxide with Acetic Acid.

Colorless, transparent or translucent prisms or tables, efflorescent, and slowly converted into carbonate on exposure to the air, with a faintly acetous odor, and a sweet, astringent and metallic taste, soluble in 2.3 parts of water and in 21 parts alcohol. The commercial salt should be purified by recrystallization for medicinal use.

*Uses.*—As an astringent in washes and injections; internally in the pill form, and in chemistry as a precipitant of various organic principles.

*Subacetate of Lead, Solution.*—Liquor Plumbi Subacetatis, U. S.—Sometimes called Goulard's Extract. Made by boiling a solution of

Acetate of Lead in Distilled Water with Oxide of Lead (litharge) until no more oxide is dissolved, or it is converted into Subacetate. The water lost by evaporation is replaced constantly and Distilled Water added, so that the finished liquid shall have the sp. gr. 1.195 and contain 25 per cent of the salt.

The subacetate of lead in this solution is not a definite compound, but a mixture of Oxyacetates. Upon exposure it absorbs carbonic acid from the atmosphere and is converted into insoluble carbonate. Distilled water is therefore directed to be used in the preparation of the dilute solution or "lead water," as well as in the concentrated solution. It should be preserved in small, tightly-stoppered bottles.

*Uses.*—Only externally as an astringent and sedative and in the following official preparations:

*Liquor Plumbi Subacetatis Dilutus*, containing 3 parts of the above Solution in 100 parts of Distilled Water.

*Ceratum Plumbi Subacetatis*, prepared by mixing 20 parts of the concentrated Solution of Lead Subacetate with 80 parts of Camphor Cerate.

Also in the unofficial Liniment made by mixing 40 parts of concentrated Solution of Lead Subacetate with 60 parts of Cotton seed Oil.

*Lead Carbonate*.— $(\text{PbCO}_3)_2\text{Pb}(\text{OH})_2$ .—*Plumbi Carbonas*, U. S.—White Lead.—Obtained by the reaction of Carbonic Acid on the Acetate.

Heavy, white powder, odorless, tasteless, permanent in the air, and insoluble in water and alcohol. When heated strongly, it changes to yellow, losing carbon dioxide and being converted into the oxide.

*Uses.*—Externally as a protective to irritated surfaces, but owing to its poisonous character it cannot safely be applied except to the unbroken skin. It is largely used in the arts, ground in oil, as Paints.

*Off. Prep.*—*Unguentum Plumbi Carbonatis*.

*Lead Nitrate*.— $\text{Pb}(\text{NO}_3)_2$ .—*Plumbi Nitrás*, U. S.—Made usually by treating Litharge, or the Carbonate with Dilute Nitric Acid.

Colorless, transparent or nearly opaque octahedra, sp. gr. 4.4, permanent in air, and soluble in 2 parts of water, and nearly insoluble in alcohol at 15°C.

*Uses.*—In preparing the Iodide, and to a limited extent in medicine as a dis-cutient and as a deodorizing agent.

*Lead Iodide*.— $\text{PbI}_2$ .—*Plumbi Iodidum*, U. S.—Obtained by mixing a solution of Lead Nitrate and Potassium Iodide.

The precipitate obtained is a bright yellow powder, inodorous, of a somewhat metallic taste, turns brick-red when heated, and if in contact with the air, gives off iodine and is converted into oxyiodide, which is citron-yellow in color. Almost insoluble in alcohol or water.

*Uses.*—Externally in ointment, chiefly.

*Off. Prep.*—*Unguentum Plumbi Iodidi*.

## COPPER.—Cu.

This metal occurs in considerable abundance, both native and combined. Its most important ores are the Black Oxide or melanconite, the Red Oxide, malachite, azurite, chalcocite or copper glance, and chalcopyrite or copper pyrites.

The methods of extracting the copper differ, according to the nature of the ores.

*Cuprum.*—Cu.—A red metal with a bright, metallic lustre, very tough, malleable and ductile, has a sp. gr. of 8.94, is next to silver in its conductivity of heat and electricity, and fuses at a bright-red heat. It forms two oxides: Red oxide and black oxide of copper.

*Copper Sulphate.*— $\text{CuSO}_4 + 5\text{H}_2\text{O}$ .—Cupri Sulphas, U. S.—Blue Vitriol.—Obtained by oxidizing the Sulphide or by the action of Dilute Sulphuric Acid on the Metal. This is the most Common Salt of Copper and from it all other compounds are made.

Large, deep-blue, translucent, triclinic crystals, which on exposure to the air effloresce. They have an acid reaction, are without odor, and have a disagreeable metallic taste. Soluble in 2.6 parts of water at 15° C., and insoluble in alcohol. Converted by a temperature a little above 230° C. into the anhydrous salt, and at a red-heat are decomposed.

*Uses.*—Chiefly in Collyria, Injections, Lotions, and occasionally as an emetic, or in smaller doses as a tonic and astringent. As a reagent in various Test Solutions and in Fehling's Solution. [See U. S. Ph., p. 483.]

*Cuprum Ammoniation.*—Made by rubbing together in a mortar, until effervescence ceases, Sulphate of Copper 4 parts, Carbonate of Ammonia 3 parts, and drying the resulting mass on bibulous paper at a gentle heat. Used as a Test Solution and also for coloring show-liquids. Not official.

*Copper Acetate.*— $\text{Cu}(\text{C}_2\text{H}_3\text{O}_2)_2 + \text{H}_2\text{O}$ .—Cupri Acetas, Verdigris.—It is variously prepared, but may be obtained by mixing solutions of Lead Acetate and Copper Sulphate, when Lead Sulphate will be precipitated and Copper Acetate remain in solution. It is not official.

Deep blue-green, rhombic prisms, opaque or translucent, efflorescent, odorless, taste disagreeable, metallic, and with an acid reaction.

*Uses.*—Chiefly in Collyria, Lotions, and as an ingredient in Corn remedies.

*Tincture Copper Acetate.*—Rademacher. Prepared by digesting 90 parts Copper Sulphate and 112.5 parts Lead Acetate with 510 parts water. The mixture is boiled, and when cold, 390 parts Alcohol added, frequently agitated for 4 days, and the solution obtained by filtration.

The Salts of Copper are not poisonous, but its double compound with arsenic, the aceto-arsenite of copper, or "Paris Green," is exceedingly *poisonous*.

## TIN.—Sn.

This metal is rarely found native. Its principal ore is cassiterite, or tin-stone,  $\text{SnO}_2$ , but it also exists in the form of tin pyrites, which is a compound of copper, zinc, iron and tin with Sulphur; in the form of silicate, and in small proportion in several complex minerals.

It is obtained from Tin-stone by crushing and washing to separate lighter impurities, roasting to oxidize sulphides that may be present, washing a second time to get rid of lighter oxides that may be present; and then reduction of the purified tin oxide thus produced, in a suitable furnace with anthracite or charcoal.

*Stannum*.—Sn.—Brilliantly lustrous, white metal, melting at 235° C., volatilizing at a white heat, sp. gr. 7.293, exhibits a fibrous fracture, when bent produces a crackling sound, is somewhat harder than lead, malleable and ductile, but not very tenacious.

As tin is not readily oxidized in moist air, it is highly valuable for coating iron and copper surfaces, which is its principal use in the arts.

All the compounds and preparations of tin are *poisonous*.

*Tin Chloride*.— $\text{SnCl}_2 \cdot 2\text{H}_2\text{O}$ .—Stannous Chloride.—Obtained by dissolving Tin in hot Hydrochloric Acid, is used as a reagent, and largely in the arts and manufactures.

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## GOLD.—Au.

The only Compound of Gold used in medicine is:

*Gold and Sodium Chloride*.— $\text{AuCl}_3 \cdot \text{NaCl}$ .—Auri et Sodii Chloridum, U. S.—“Double Chloride of Gold and Sodium.” A mixture of equal weights of Gold Chloride and Sodium Chloride. Obtained by dissolving Gold in Nitrohydrochloric Acid, adding Sodium Chloride and evaporating the solution to dryness.

An orange-yellow powder, very deliquescent, and soluble in water.

Used as a tonic in dipsomania, etc.

## CADMIUM.—Cd.

*Cadmium Bromide*, though an unofficial salt, is sometimes used in pharmacy. It is prepared by double decomposition of solutions of cadmium sulphate and potassium bromide.

# Silver and Mercury.

## SILVER.—Ag.

Silver occurs both free and in combination. Its most important ores are silver glance ( $\text{Ag}_2\text{S}$ ), ruby silver ( $\text{Ag}_3\text{SbS}_3$ ), silver-copper glance ( $\text{AgCu}_2\text{S}$ ), and horn silver ( $\text{AgCl}$ ). It is obtained from the ores by processes which differ considerably, according to the nature of the ores, their purity, etc.

*Argentum*.—Ag.—A bright, white metal, susceptible of a high degree of polish, the best conductor of heat and electricity, tenacious, malleable, and very ductile, fuses at  $1040^{\circ}\text{C}.$ , and volatilizes at a white heat. Its specific gravity is about 10.5.

*Uses*.—In pharmacy in the preparation of silver compounds. Its surgical uses are also numerous, because it is not readily oxidized.

## SILVER COMPOUNDS.

*Silver Nitrate*.— $\text{AgNO}_3$ .—*Argenti Nitratas*, U. S.—Obtained by treating Silver with dilute Nitric Acid. This is the most important salt of silver, and from it all the other compounds are produced.

Colorless, transparent, tabular, rhombic crystals, odorless, very caustic and bitter taste, and of neutral reaction. Soluble in 0.6 parts of water, in 26 parts of alcohol, and in 5 parts boiling alcohol. The crystals and aqueous solution are permanent and not affected by light, but when exposed to the air become rapidly dark in color, owing to decomposition induced by contact with organic matter.

*Uses*.—In medicine chiefly as a local remedy, either in solution, as a wash, or in substance moulded into Sticks (lunar caustic) for cauterization. Internally in the pill-form, in doses of about 2 cg., the mass being made with an excipient of indifferent character to prevent reduction of the salt. It is used largely as a Hair Dye, and for Indelible Ink, owing to its property of leaving a permanent black stain upon organic matter. Stains upon the skin may be removed by a solution of potassium cyanide. Taken internally in large doses it is poisonous sodium chloride being the proper antidote.

From nitrate of silver are prepared the following:

*Argenti Nitratas Dilutus*, U. S.—Prepared by fusing together one part of Silver Nitrate and two parts Potassium Nitrate, and casting into cones or cylindrical sticks,

*Argenti Nitratas Fusus*, U. S.—Lunar Caustic.—Made by fusing the Nitrate and adding a little Hydrochloric Acid to the melted mass, which is then cast into sticks. The small amount of Silver Chloride contained in this form of the salt makes it tough and the sticks less friable.

*Silver Oxide*.— $\text{Ag}_2\text{O}$ .—*Argenti Oxidum*, U. S.—Obtained by

pouring a solution of Silver Nitrate into either a solution of Lime or of Caustic Potash.

Inodorous, brownish or blackish powder, undergoing reduction or partial reduction on exposure to light; its uses are similar to those of the nitrate. It should not be triturated with readily oxidizable or combustible substances, nor brought in contact with Ammonia.

*Silver Iodide.*—AgI.—Argenti Iodidum, U. S.—Obtained by mixing a solution of Silver Nitrate with one of Potassium Iodide.

An amorphous light-yellow and heavy powder that is inodorous, tasteless, and insoluble in the ordinary solvents.

Its medicinal use is limited.

*Silver Cyanide.*—AgCN.—Argenti Cyanidum, U. S.—Made by conducting a stream of Hydrocyanic Acid, distilled from a mixture of Potassium Ferrocyanide and Sulphuric Acid, into a solution of Silver Nitrate, and washing and drying the precipitate.

White, amorphous powder, permanent in dry air, but slowly growing brown by exposure to the light. It is without odor and taste, and not soluble either in alcohol or water; exceedingly poisonous.

*Off. Prep.*—Acidum Hydrocyanicum Dilutum.

#### MERCURY.—Hg.

This is the only metal that is liquid at ordinary temperatures. It is sometimes found free in nature in minute globules, but is usually obtained from its ores, the chief of which is Cinnabar, an impure Sulphide of Mercury. The metal is obtained by roasting the ores in a suitable furnace. The sulphur burns and the mercury volatilizes and is collected in a cooling chamber to which the vapors are conducted.

*Mercury.*—Hydrargyrum, U. S.—Quicksilver.—A silvery, mobile liquid, having a sp. gr. of 13.559, solidifying at  $-39^{\circ}\text{C}.$ , and boiling at  $357.2^{\circ}\text{C}.$  It forms two series of salts, the *mercurous* and *mercuric*.

#### PREPARATIONS OF MERCURY.

Mercury in all its forms is active, and in its more soluble forms, highly poisonous. It acts powerfully on the glandular system, and is useful in many cases, both of local and general inflammation. The metal itself, in the liquid form, is not often medicinally employed, but by triturating it for a long time with fats, chalk or sulphur, it is mechanically reduced to a fine state of division, and in this form possesses more active properties, and has important medicinal uses. The following preparations contain mercury in the *metallic* form:

*Mass of Mercury.*—Massa Hydrargyri, U. S.—Blue Mass.—Contains one-

third its weight of Mercury made into a mass with Licorice, Althea, and Honey of Rose, with the addition of 3 per cent of Glycerin to keep it soft.

*Mercury with Chalk*.—Hydrargyrum cum Creta, U. S.—Contains 38 per cent of Mercury, triturated with Honey and Prepared Chalk, until so finely divided that no globules of mercury are visible with a lens magnifying no less than 4 diameters.

*Mercurial Ointment*.—Unguentum Hydrargyri, U. S.—“Blue Ointment.”—Containing one-half its weight of Mercury. The Mercury is extinguished with a little Mercury Oleate and incorporated with Lard and Suet.

*Mercurial Plaster*.—Emplastrum Hydrargyri, U. S.—Containing 30 per cent of Mercury with Lead Plaster.

*Ammoniac Plaster with Mercury*.—Emplastrum Ammoniaci cum Hydrargyro, U. S.—Containing 18 per cent of Mercury with Ammoniac and Lead Plaster.

#### COMPOUNDS OF MERCURY.

Mercury is *bivalent* and forms two classes of salts, i. e., mercurous and mercuric compounds.

In the *mercurous* compounds two atoms of mercury combine with the salt-producing radical, while in the *mercuric* one atom of the metal exerts its bivalence. This distinction is best shown by the formulas of the official compounds as follows:

Compounds of	<i>Mercurous.</i>	<i>Mercuric.</i>
O.	.....	Oxide=HgO
Cl.	Chloride=Hg <sub>2</sub> Cl <sub>2</sub>	Chloride=HgCl <sub>2</sub>
I.	Iodide=Hg <sub>2</sub> I <sub>2</sub>	Iodide=HgI <sub>2</sub>
S.	.....	Sulphate=HgSO <sub>4</sub>
NH <sub>4</sub>	.....	Ammon-Chlor=NH <sub>2</sub> HgCl
CN.	.....	Cyanide=Hg(CN) <sub>2</sub> .

The Mercuric Chloride, Sulphate, and Cyanide are the only compounds sparingly soluble in water and more freely soluble in alcohol, as is also the Iodide. The *Mercurous* compounds are almost insoluble in either water or alcohol.

The two classes of compounds are distinguished by the following reactions:

Hydrochloric Acid with mercurous salts white precipitate; with mercuric no precipitate.

Potassium Iodide with mercurous salts greenish-yellow precipitate; with mercuric, yellow precipitate turning scarlet.

Ammonia Water with mercurous salts, black precipitate; with mercuric a white precipitate.

Compounds of mercury are more or less affected by light and should be protected against it by being kept in dark-colored bottles.

Mercury forms with Sulphur five compounds: Red Mercuric Sulphide, HgS, found native, and from which mercury is chiefly derived; also Black Sulphide of the same composition; Mercuric Sulphate, HgSO<sub>4</sub>, by reaction of sulphuric acid on the metal; Yellow Mercuric Subsulphate, Hg(HgO)<sub>2</sub>SO<sub>4</sub>, by decomposition of the mercuric sul-

phate in boiling water, and Mercurous Sulphate,  $Hg_2SO_4$ , made by direct union of the metal with mercuric sulphate, or with sulphur.

*Red Mercuric Sulphide*.— $HgS$ .—Hydrargyri Sulphidum Rubrum.—Commonly known as Cinnabar.—Occurs native, and in that form constitutes one of the principal ores of mercury. It is also made by heating together Mercury and Sulphur, in proper proportions, and finally subliming the mixture.

In the form of brilliant, dark red masses, having a crystalline structure, or else a bright scarlet powder; inodorous, tasteless, permanent in the air; insoluble in water or alcohol; it turns dark on heating, but resumes its normal hue again on cooling. The pure sulphide, used in the arts as Vermilion, is completely volatilized by heat, which is not true of samples adulterated with red lead, or with basic lead chromate. Seldom used medicinally.

*Black Mercuric Sulphide*, or "Ethiop's Mineral," has the same composition, and is made by fusing together equal parts of sulphur and mercury.

*Yellow Mercuric Subsulphate*.— $Hg(HgO)_2SO_4$ .—Hydrargyri Subsulphas Flavus, U. S.—"Turpeth Mineral."—The normal sulphate is added to boiling distilled water and heated, when upon cooling of the mixture the compound precipitates, is washed and dried.

Heavy, bright lemon-yellow powder, unchangeable in the air, odorless, slight metallic taste, sp. gr. 6.44, very slightly soluble in cold water, insoluble in alcohol, and when heated turning red, but resuming its original color on cooling. It is a powerful irritant poison. But little used medicinally.

*Mild Mercurous Chloride*.— $Hg_2Cl_2$ .—Hydrargyrum Chloridum Mite, U. S.—Calomel.—Mild Chloride of Mercury.

Obtained by the double decomposition of Mercurous Sulphate and Sodium Chloride. Mercurous Sulphate is mixed with Sodium Chloride in a suitable retort and subjected to heat:  $Hg_2SO_4 + 2NaCl \rightarrow Hg_2Cl_2 + Na_2SO_4$ . The calomel is sublimed and collected in a cool chamber, when it is washed with water to free it from the soluble mercuric chloride, and then dried.

A white impalpable powder, showing small isolated crystals under the microscope, assuming a yellowish coloration upon trituration, and becoming grayish upon exposure to light. Insoluble in neutral solvents, but decomposed by strong acids and colored black by ammonia water. It should be kept in dark amber-colored bottles.

*Caution*.—In contact with the chlorides of ammonium, potassium and sodium, it undergoes a change into mercuric chloride, and great care should, therefore, be observed in dispensing calomel in conjunction with these substances.

*Uses*.—In medicine as a cathartic, and externally as a wash combined with lime water.—*Lotio Nigra*, N. F.

*Off. Prep.*.—Pilulae Antimonii comp.; Pilulae Catharticae comp.

*Corrosive Mercuric Chloride.* —  $\text{HgCl}_2$ . — Hydrargyri Chloridum Corrosivum, U. S.—Corrosive Chloride, or Bichloride of Mercury.—Corrosive Sublimate.—Made by the double decomposition of Mercuric Sulphate and Sodium Chloride, heating the mixture and obtaining the mercuric chloride by sublimation.

Heavy white crystalline masses, or colorless rhombic prisms. Sp. gr. 5.4, fuses at  $265^{\circ}$  C. and at  $300^{\circ}$  C. sublimes without residue. Permanent in air, inodorous (but its dust very irritating), with an acrid metallic taste, soluble in 16 parts of water at  $15^{\circ}$ , in 3 parts of alcohol, in 4 parts of ether and in 14 parts of glycerin. It is a powerful irritant poison. Antidote: White of egg or milk.

*Uses.*—In making many mercury compounds in medicine, as an alterative and externally as an antiseptic. It is the most powerful of all known antiseptics, but owing to its poisonous properties it must be used only with great care. With potassium iodide it forms a double compound, a solution of it being a valuable reagent for the alkaloids (*Mayer's Solution*). With Lime Water it forms a yellow mixture, *Lotio Flava*, "Yellow Wash," N. F.

*Dose.*—Internally from 4 to 16 mg. ( $\frac{1}{6}$  to  $\frac{1}{4}$  gr.)

*Yellow Mercuric Oxide.* —  $\text{HgO}$ . — Hydrargyri Oxidum Flavum, U. S.—Obtained by mixing solutions of Mercuric Chloride and Soda, and collecting, thoroughly washing and drying the precipitate.

A light orange-yellow, amorphous, heavy impalpable powder, permanent in the air, but becoming darker on exposure, and should, therefore, be protected from the light, odorless, tasteless, insoluble in water and alcohol, and changing to red when strongly heated.

*Off. Prep.*—*Oleatum Hydrargyri*; *Ung. Hydrargyri Oxidi Flava*.

*Yellow Mercurous Iodide.* —  $\text{Hg}_2\text{I}_2$ . — Hydrargyri Iodidum Flavum, U. S.—Hydrargyrum Iodidum Viride.—Protiodide, Yellow, or Green Iodide of Mercury.—Obtained by precipitating an acid Solution of Mercurous Nitrate with Potassium Iodide, thoroughly washing and drying the precipitate formed.

A bright yellow amorphous powder, odorless and tasteless, which becomes darker colored on exposure to the light, without odor or taste, insoluble in alcohol, and nearly so in water. It is less poisonous than the red iodide.

*Uses.*—Chiefly in treatment of syphilis in the pill-form, in doses 8 mg. to 3 deg. ( $\frac{1}{6}$  to  $\frac{1}{2}$  gr.)

*Red Mercuric Iodide.* —  $\text{HgI}_2$ . — Hydrargyri Iodidum Rubrum, U. S.—Biniodide of Mercury.—Obtained by the reaction of Potassium Iodide and Mercuric Chloride in solution.

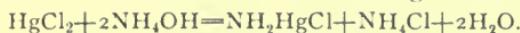
Scarlet red, crystalline powder, without color or taste, permanent in air, nearly insoluble in water and soluble in 130 parts of alcohol, and in 15 parts of boiling alcohol; also soluble in solutions of potass. iodide or mercuric chloride. A powerful irritant poison.

*Uses.*—Occasionally given in syphilis, either alone in the pill form, or in solu-

tion in conjunction with potassium iodide, but mainly used externally in treatment of skin diseases, glandular swellings, etc,

*Off. Prep.*—Liquor Arseni et Hydrargyri Iodidi.

*Ammoniated Mercury.*— $\text{NH}_2\text{HgCl}$ .—Hydrargyrum Ammoniatum, U. S.—White Precipitate.—Obtained by decomposing a solution of Mercuric Chloride in Ammonia Water in excess a white precipitate of mercuric ammonium chloride being formed:



This, after being washed, is dried between sheets of filter paper at a gentle heat.

It is used only in the form of ointment.

*Unguentum Hydrargyri Ammoniati.*—U. S., strength 10 parts to 90 of Benzoinated Lard.

*Mercuric Nitrate.*— $\text{Hg}(\text{NO}_3)_2$ .—Hydrargyri Nitratis.—Made by dissolving metallic Mercury in Nitric Acid. It is official in the following forms:

*Liquor Hydrargyri Nitratis.*—U. S.—Containing 60% by weight of Mercuric Nitrate with some free nitric acid; sp. gr. of the solution 2.100.

*Unguentum Hydrargyri Nitratis.*—U. S.—Citrine Ointment.—Prepared by mixing a solution of Mercuric Nitrate with Lard Oil, previously acted upon by nitric acid in order to prevent the decomposition of the mercuric nitrate

*Red Mercuric Oxide.*— $\text{HgO}$ .—Hydrargyri Oxidum Rubrum, U. S.—Red Precipitate. Usually obtained by decomposing Mercuric Nitrate by means of heat.

Crystalline, red or orange-red, heavy powder, or scales, permanent in air, odorless, tasteless, insoluble in water and alcohol. It turns darker when heated, and at a high temperature evolves oxygen and is reduced to the metallic state.

*Off. Prep.*—Unguentum Hydrargyri Oxidi Rubri.

It will be observed there is no chemical difference between the Yellow and Red Oxides, both being *Mercuric* compounds. The difference in color is due to a variation in the arrangement of the molecules derived from the different methods of producing the two oxides.

*Mercuric Cyanide.*— $\text{Hg}(\text{CN})_2$ .—Hydrargyri Cyanidum, U. S.—Obtained by dissolving Mercuric Oxide in Hydrocyanic Acid, produced by treating Potassium Ferrocyanide with Sulphuric Acid.

Colorless, or white quadrangular prisms, permanent in air, inodorous, bitter metallic taste, if kept from the light, permanent in the air, and soluble at 15 C. in 12.8 parts of water and 15 parts of alcohol. It is very poisonous.

*Uses.*—Similar to mercuric chloride, but a dangerous and little used remedy.

# Antimony.—Bismuth.

## ANTIMONY.—Sb.

This metal rarely occurs in the native state. Its most common ore is stibnite,  $Sb_2S_3$ , but many others are known, as a compound of iron, antimony and sulphur; of copper, antimony and sulphur; and a compound of lead, antimony and sulphur, etc.

*Stibium*.—Sb.—Lustrous, silver-white metal, of a crystalline structure, and at ordinary temperatures brittle; fuses at  $425^{\circ}\text{C}.$ , volatilizes at a red heat, and at the temperature of its melting point readily oxidizes in the air, but remains unchanged at ordinary temperatures. Its sp. gr. is about 6.86.

The most common compound is the Sulphide from which the other sulphur compounds of Antimony are made.

*Antimony Sulphide*.— $Sb_2S_3$ .—Antimonii Sulphidum, U. S.—This occurs, as above stated, in nature as the mineral stibnite. It is freed from the impurities, with which the native mineral is usually associated, by fusion, the impurities mostly remaining behind, while the fused Sulphide is poured off.

In masses of a steel-gray color, more or less striated, and of a metallic lustre, forming, when pulverized, a dull grayish powder, which is insoluble in alcohol or water, and without odor or taste. It may be distinguished from black oxide of manganese, which it outwardly resembles, by its ready fusibility.

*Uses*.—It is seldom used in medicine, but constitutes the chief source of the metal and of the various compounds of antimony.

*Purified Antimony Sulphide*.—Antimonii Sulphidum Purificatum, U. S.—The finely powdered sulphide is freed from coarse particles by elutriation and macerated for five days in Ammonia Water, which dissolves the arsenic. The powder, after being washed, is finally dried.

A heavy grayish-black powder, insoluble in water or alcohol.

Its chief use is in the preparation of the following:

*Sulphurated Antimony*.—Antimonium Sulphuratum, U. S.—“Kermes Mineral.”—Consists chiefly of Antimonious Sulphide mixed with a small amount of Antimonious Oxide. Obtained by dissolving the purified sulphide in an aqueous solution of one of the Fixed Alkalies, and then precipitating it by means of Dilute Sulphuric Acid.

An amorphous, reddish-brown powder, inodorous, tasteless, and insoluble both in water and alcohol. When heated with twelve times of hydrochloric acid it is nearly all dissolved with the evolution of hydrogen sulphide.

*Uses*.—It is not much used at present in medicine, but has the essential properties of other antimony compounds.

*Off. Prep.*.—Pilulae Antimonii compositæ.

*Antimony Oxide*.— $\text{Sb}_2\text{O}_3$ .—Antimonii Oxidum, U. S.—This oxide exists in nature as the mineral cervatite, but it is usually prepared for medicinal use from the Chloride by precipitation in water.

A heavy, grayish-white powder, but slightly soluble in water, and insoluble in alcohol. Soluble in hydrochloric and tartaric acids, and in hot solution of potassium bitartrate. When heated to a bright red heat it sublimes and forms crystals called flowers of antimony.

*Uses*.—In pharmacy to prepare Tartar Emetic, and occasionally in medicine as a nauseant, sudorific or emetic.

*Off. Prep.*.—Pulvis Antimonialis.

*Antimony and Potassium Tartrate*.— $2\text{K}(\text{SbO})\text{C}_4\text{H}_4\text{O}_6 + \text{H}_2\text{O}$ .—Antimonii et Potassii Tartras, U. S.—Tartar Emetic.—Made by the action of Acid Tartrate of Potassium on Oxide of Antimony, in the presence of Water.

Colorless, transparent crystals of small size, in the form of rhombic octahedra which, on exposure to the air, become white and opaque, are inodorous, have a sweetish, followed by a disagreeable, metallic taste. Soluble in 17 parts water at 15° C., in 3 parts of boiling water, insoluble in alcohol, which precipitates it from aqueous solution as a fine crystalline powder.

*Uses*.—As a test; in preparing compounds, and in medicine as an emetic and irritant. As an antidote tannin should be given.

*Off. Prep.*.—Syrupus Scillæ compositus; Vinum Antimonii.

### BISMUTH—Bi.

Bismuth exists in the metallic state in some localities. The commercial supply is chiefly derived from the mines in Saxony, where it occurs associated with silver, cobalt, and nickel. It also exists as the oxide and sulphide, and in other combinations. It is readily separated from the metals, with which it is alloyed, by taking advantage of its comparatively low fusing-point.

*Bismuthum*.—Bi.—Hard, brittle, bright, metallic luster, crystalline structure, grayish, with a reddish tinge, sp. gr. 9.823, melts at 270° C., and expands in solidifying. The metal itself is not used in medicine.

### COMPOUNDS OF BISMUTH.

*Bismuth Subnitrate*.— $\text{BiONO}_3 + \text{H}_2\text{O}$ .—Bismuthi Subnitras, U. S.—Obtained by dissolving the metal in Nitric Acid, pouring the concentrated solution into Ammonia Water, redissolving the precipitated hydroxide in Nitric Acid and again precipitating with a solution of Sodium Carbonate; the Subcarbonate so formed is again dissolved in Nitric Acid and the solution poured into ammoniated water, the Subnitrate precipitates, is washed and dried.

Heavy, white powder of somewhat varying chemical composition permanent

In the air, odorless, tasteless, and insoluble in water and alcohol. At a red heat it, like the subcarbonate, is converted into yellow bismuthous oxide.

*Uses.*—Internally, either alone or in conjunction with pepsin, in disorders of the stomach and alimentary canal, where, owing to its insolubility, it protects inflamed surfaces. Externally as injection and Ointment, and popularly as a snuff in catarrh.

Also for preparing Citrate of Bismuth, and several unofficial compounds

*Bismuth Citrate.*— $\text{BiC}_6\text{H}_5\text{O}_7$ .—Bismuthi Citras, U. S.—Obtained by boiling the Subnitrate, in a solution of Citric Acid.

White, amorphous powder, permanent in the air, odorless, tasteless, insoluble in water and alcohol, but soluble in water of ammonia citrates and alkalies.

*Uses.*—Similar to subnitrate and subcarbonate, and to prepare the citrate of bismuth and ammonia.

*Bismuth and Ammonium Citrate.*—Bismuthi et Ammonii Citras, U. S.—Made by dissolving Bismuth Citrate in weak Ammonia-Water, filtering and evaporating the liquid until it is of a syrupy consistence, spreading upon glass-plates and allowing it to dry, when the salt is obtained in scales.

Pearly or nearly transparent scales, becoming opaque on exposure to the air, of neutral or faintly alkaline reaction, very soluble in water, but sparingly in alcohol. The salt loses ammonia if not carefully protected from the air, and becomes insoluble in water, but when the liquid is rendered slightly alkaline by addition of ammonia-water, it becomes again easily soluble.

*Uses.*—In many Elixirs associated with iron, quinine, hydrastine, strychnine, pepsin, etc. With pepsin, which requires an acid solvent, the sodio-bismuth tartrate has been employed, instead of the ammonio-citrate of bismuth, the latter being precipitated in acidulated solutions.

*Liquor Bismuthi* contains two grains of the ammonio-citrate in one fluid drachm. See Nat. Form.

*Bismuth Subcarbonate.*— $(\text{BiO})_2\text{CO}_3 + \text{H}_2\text{O}$ .—Bismuthi Subcarbonas, U. S.—Obtained by dissolving Metallic Bismuth in Nitric Acid, and pouring the solution into Ammonia Water, dissolving the washed precipitate in Nitric Acid and pouring the solution of the Nitrate thus formed into a solution of Sodium Carbonate, similarly to the first steps in the process for making the Subnitrate, collecting and thoroughly washing and drying the precipitate.

Whitish, or slightly yellowish, amorphous powder, of somewhat varying chemical composition, unchangeable in the air, inodorous, tasteless, insoluble in water and alcohol, and at a red heat, is converted into yellow bismuth oxide.

*Uses.*—Same as subnitrate, which see.

# Cellulose and Derivatives.

Cellulose or Cellulin constitutes the principal portion of the cell-walls of plants, and together with one of its modifications, *lignin*, it represents the greater proportion of dried wood. Because of its wide distribution Cellulose is an important substance, and in some of its modifications, such as cotton, paper, wood and coal, is the most nearly indispensable substance to mankind.

*Cellulose* has the same chemical composition as Starch,  $C_6H_{10}O_5$ , or a multiple of this and, like it, may by the action of acids be converted into glucose. These substances have therefore been designated chemically as the Cellulin group and have been thus treated in works of chemistry. For the purposes of pharmacy, however, this classification is not desirable, as each class is best studied by itself.

Pharmaceutically and chemically considered Cellulose furnishes some of the most important chemical and technological agents, which may be grouped according to the methods of manufacture as follows:

## *Cellulose:*

### A. By separation of Lignin and impurities:

1. Mechanical.—Cotton, Linen, Jute.
2. Pharmaceutical.—Paper, Purified Cotton, Lint.

### B. By chemical decomposition:

3. By Nitration.—Nitro-Cellulin—Pyroxylin.
4. From oxalates with  $H_2SO_4$ , Oxalic Acid.
5. By destructive distillation:

	Percentage.
Incondensable Gases .....	25
Pyroligneous Acid.....	40
Tarry Liquid .....	10
Solid, Charcoal, etc.....	25
	<hr/>
	100

These will be treated in the order that they are derived, together with their compounds and preparations.

## FORMS AND MODIFICATIONS OF CELLULOSE.

Cellulose occurs in a fairly pure form in the bast-cells of certain plants, such as the Flax, Hemp, etc., and in a still purer form in the hairs attached to the seed of the Cotton plant.

They consist of single, elongated, rather thin-walled cells which, when dry, collapse and form flattened and somewhat twisted bands. But these fibers in

their natural form contain more or less coloring and resinous matter of which they must be freed before being used for making the finer fabrics and especially before they can be used in pharmacy. Their chief value in pharmacy depends upon their power of absorbing liquids due to the capillary attraction exercised by the cells, which renders these forms of Cellulose invaluable in surgery to abstract irritating liquid (pus), thus keeping the wound clean. They are also used as filtering media for the same reason.

*Purified Cotton.*—*Gossypium Purificatum. U. S.*—Absorbent Cotton.—The hairs of the seed of *Gossypium herbaceum L.*, freed from adhering impurities and deprived of fatty matter.

The “raw” cotton is boiled in an alkaline solution, washed and immersed in a solution of Chlorine, again washed with water and then with dilute Hydrochloric Acid, rinsed thoroughly in weak Alkaline water and finally in pure water and then dried.

The cotton so treated has great absorbent power, is insoluble in all ordinary solvents, but soluble in copper ammonium sulphate solution.

*Uses.*—In surgery and for the preparation of Medicated Cottons by saturating it in solutions of antiseptic agents, such as Carbolic Acid, etc., and drying.

Other forms of Cellulose used in surgery are Lint made from Linen obtained from the *Linum usitatissimum*, Hemp and Jute.

The principal modifications of Cellulose are *lignin*, the thick-celled portion of wood, and *suberin*, which constitutes the principal portion of Cork.

*Paper.*—*Charta.*—Is prepared from Cellulose direct in the form of wood, straw, or linen rags by heating with steam under pressure in revolving cylinders with Alkalies, beating into a pulp and bleaching with Chlorine. The pulp is transferred to endless felt-beltting revolving on heated cylinders and dried, the sheets finally being pressed between rollers to give them a smooth or “calendered” surface.

Paper to which no glue or similar substance has been added is called “un-sized” paper, and is the kind directed for the official Papers, prepared by soaking the paper in a saturated solution.

*Chartula* means small paper, and has reference to the paper used for enwrapping powders, hence its use in dispensing directions. For this purpose wax and paraffin paper is also employed.

*Parchment* paper is prepared by dipping unsized paper in cold 50-per-cent Sulphuric Acid, then in Ammonia Water, rinsing in pure water and finally rolling it so as to give a polished surface. The acid converts the surface of the paper into a gummy substance which gives to the paper great strength.

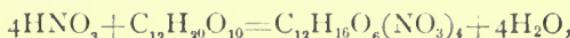
#### CELLULOSE PRODUCTS BY CHEMICAL DECOMPOSITION.

*Nitro-Cellulose*—*Gun Cotton.*—By treating Purified Cotton with a cooled mixture of Nitric and Sulphuric Acids, it is changed into Nitro-Cellulin and may contain from two to six molecules of  $\text{NO}_3$  according to the proportion of Nitric Acid used.

The di-nitrate is not soluble in ether and alcohol and is not explosive.

The *tetra-nitrate* is soluble in ether and alcohol and is slightly explosive. The *hexa-nitrate* is insoluble, is highly explosive and is the true Gun Cotton. A mixture of these, consisting chiefly of the *tetra-nitrate*, is official under the name of:

*Pyroxylin*.—*Pyroxylinum*, U. S.—Soluble Gun Cotton.—Made by immersing 10 Gm. Cotton in a mixture of 140 C.C. Nitric Acid and 220 C.C. Sulphuric Acid, cooled to 32°C.:



thoroughly washing first in water, then in Alcohol and carefully drying the product. The Sulphuric Acid simply aids the reaction.

From this the official class of Collodions are prepared by solution in Ether and Alcohol and addition of medicinal agents.

*Collodium*, U. S.—*Pyroxylin* 3 Gm., Ether 75 CC., alcohol 25 CC.

*Collodium Flexile*, U. S.—5 Canada Turpentine, 3 Castor Oil, Collodion to 100 Gm.

*Collodium Cantharidatum*, U. S.—60 Gm. Cantharides are extracted with Chloroform and the extract concentrated to 15 Gm. is mixed with Flexible Collodion to make 100 Gm.

*Collodium Stypticum*, U. S.—20 Gm. Tannic Acid dissolved in alcohol 5 C.C. and ether 25 C.C. and mixed with Collodion to make 100 C.C.

*Oxalic Acid*.— $\text{H}_2\text{C}_2\text{O}_4$ .—*Acidum Oxalicum*.—Is a dibasic acid. It is widely distributed in the vegetable kingdom, occurring as acid Potassium Oxalate in sorrel and some other plants, but more commonly in combination with Calcium in rhubarb, curcuma, etc. This latter compound is also found in the animal body.

It may be made from Sugar by the action of Nitric Acid and in other ways, but commercially it is made by heating Saw-dust with Potassa and Soda, forming Oxalates of Potassium and Sodium. By Sodium Carbonate the former is converted into Sodium Oxalate which is formed into Calcium Oxalate by the addition of Calcium Hydrate. This Calcium Oxalate is decomposed by Sulphuric Acid into insoluble Calcium Sulphate, Oxalic Acid being set free and obtained by crystallization from the solution.

Tabular crystals, colorless, intensely sour, soluble in 8 parts of cold water and in all proportions in boiling water. The pure acid does not blacken when heated on platinum foil, but melts at about 100°C. and sublimes at about 160°C., being partly decomposed into carbon monoxide and carbon dioxide. The acid is very poisonous; the proper antidote is chalk or magnesia.

Oxalic acid itself is not official, but represented in the Volumetric Solution for quantitative testing. [See U. S. Ph.]. It is used for making the Oxalates.

## PRODUCTS OF DESTRUCTIVE DISTILLATION OF WOOD.

When wood is burned in a furnace without access of air the resulting products may be summarized as follows in order of their derivation:

<i>Gases</i> .—Non-Condensable, 25%	{ Carbon monoxide, CO; dioxide, CO <sub>2</sub> . Marsh Gas, CH <sub>4</sub> ; Acetylene, C <sub>2</sub> H <sub>2</sub> . Propene, C <sub>3</sub> H <sub>6</sub> ; Ethylene, C <sub>2</sub> H <sub>4</sub> .
<i>Vapors</i> .—Condensable Liquid, 50%	{ Acetone, Furfurol. Methyl Alcohol, Methylamine. Acids.—Acetic, Formic, Butyric. Crotonic, Capronic, Propionic.
<i>Tarry Liquid</i> , 10%	{ Tar, Creosote. Toluol, Xylol, Cumol, Methol. Cresol, Phlorol. Naphthalene, Pyrene, Chrysene. Paraffin.
Solid Residue, 15%	{ Charcoal, Inorganic Salts

The *Gases* are of but little importance, sometimes being utilized as fuel during the process of distillation.

The *liquid* obtained after separation from the tarry portion constitutes the so-called *pyroligneous acid*, or “crude wood vinegar.” This is treated with Lime which neutralizes the acids forming Calcium Acetate, etc., and upon distillation yields the readily vaporizable liquids, Acetone and Methyl Alcohol which come over and are condensed in the order of their respective boiling points.

*Acetone*.—C<sub>3</sub>H<sub>6</sub>O. — *Pyroacetic Ether*.—Chemically known as dimethyl ketone, is a very volatile liquid, boils at 56°C. and is the first liquid that comes over in the distillation of wood. It has the sp. gr. of 0.800, soluble in all proportions of water, alcohol and ether.

It has great solvent properties, readily dissolving gun-cotton, camphor, resins, oils, etc. It is used for the production of Chloroform and Acetophenon or Hypnon, a liquid of hypnotic properties.

*Methyl Alcohol*.—CH<sub>3</sub>OH.— Commonly called “wood alcohol” or “wood naphtha.” The product obtained as above, purified by rectification.

Limpid, colorless, volatile liquid, of a peculiar odor, and a warm alcoholic taste, sp. gr. 0.820, boiling point 65°C., soluble in all proportions of water, alcohol and ether.

*Uses*.—It is not used in medicine but as a solvent for fixed and volatile oils, resins, etc., largely in the arts. Methylated spirit is common alcohol mixed with 25 per cent of methyl alcohol, used in England for industrial purposes, free from internal revenue tax.

*Acetic Acid*.—HC<sub>2</sub>H<sub>3</sub>O<sub>2</sub>.—A monatomic acid having one replaceable hydrogen atom.

Found in plant-juices free and combined with Calcium and Potassium especially in the wood. Also in animal organism, in the perspiration and in the urine.

Acetic Acid may be obtained in many ways:

1. By decomposition through oxidation and fermentation.
2. Through oxidation of alcohol.
3. By distillation of wood and
4. Through decomposition of acetates.

Commercially it is chiefly obtained from crude Calcium Acetate obtained by destructive distillation of wood as above referred to.

The calcium acetate is dissolved in water and after settling, the clear liquid is drawn off and treated with sodium sulphate; in the double decomposition which takes place, insoluble calcium sulphate and soluble sodium acetate are formed. The clear liquid containing the sodium acetate is now drawn off, evaporated to dryness, heated to about 260°C., to char any remaining organic impurities, the residue dissolved in water, and the clear liquid separated from the sediment. By treating the liquid with sulphuric acid, separating from the crystals of sodium sulphate that have been formed, the acid is obtained by distillation.

In the *oxidation method* or the "quick vinegar process," a dilute alcoholic solution (5 to 7%) is permitted to drip slowly through a large cask filled with clean wood shavings. The cask is perforated with holes for free circulation of air. Before adding the dilute alcohol, a small quantity of warm vinegar is poured in, and some fermented malt liquor, or some "mother of vinegar." The latter contains microscopic plants (*mycodermi aceti*), which act as a ferment. The alcoholic solution is now permitted slowly to drip through the cask; soon the shavings become coated with the ferment organisms, oxidation of the alcohol takes place, the temperature of the interior of the cask rises, causing a free circulation of air, and the alcoholic solution is now rapidly converted into a more or less impure solution of acetic acid, which issues in a slow stream from an orifice in the bottom of the cask, and is called vinegar.

Vinegars are also made by fermentation of the poorer qualities of wine (wine vinegar), of cider (cider vinegar), of malt (malt vinegar), etc. In all these processes, alcohol is first produced by the fermentation of a saccharine solution, and then the alcohol, by agency of the *mycodermi aceti* and exposure of the liquid to the air, is oxidized to acetic acid. Pure acetic acid may be obtained from vinegar by a process similar to that which has been described for obtaining it from wood vinegar.

Acetic Acid is official in the following forms:

*Acetic Acid.*—Acidum Aceticum, U. S.—A liquid composed of 36 per cent of absolute acid and 64 per cent by weight of water; sp. gr. 1.048.

A clear, colorless liquid, having a strong, vinegar-like odor, a purely acid taste and a strongly acid reaction, miscible in all proportions with water alcohol, etc.

The percentage strength of Acetic Acid is not accurately disclosed by its

specific gravity, as this varies irregularly, but is best determined by the Volumetric Solution of Potassium Hydrate. [See U. S. Ph.]

*Dilute Acetic Acid.*—Acidum Aceticum Dilutum, U. S.—A liquid containing 6 per cent by weight of absolute acid. Prepared by mixing 100 Gm. of the official Acid with Distilled water to make 600 Gm.; sp. gr. 1.008.

This is used as a menstruum for the official Vinegars.

*Glacial Acetic Acid.*—Acidum Aceticum Glaciale, U. S.—Nearly or quite absolute acid, 99 per cent; sp. gr 1.058.

Liquid at ordinary temperature but becoming a crystalline mass below 15°C. Commercial Acetic Acid, or "No. 8," contains about 28 per cent of acid. It possesses a disagreeable empyreumatic odor and taste, which unfits it for medicinal purposes.

*Tar.*—Pix Liquida, U. S.—Product of the destructive distillation of the wood of various species of Pine. Mainly produced in North Carolina.

Blackish-brown, thick semi-fluid, odor empyreumatic and terebinthinate; taste bitter, empyreumatic, and somewhat acrid; soluble in alcohol, ether, chloroform, solutions of soda and potash, the fixed and volatile oils, and sparingly soluble in water.

*Composition.*—Very complex and somewhat variable, consisting of the end-products of the destructive distillation of wood, as already stated, including creosote, phenol, naphthalin, etc., associated with resin.

*Uses.*—Stimulant and irritant. Given internally, and used also externally in ointments and plasters, and for fumigations.

*Off. Prep.*—Syrupus Picis Liquidæ; Unguentum Picis Liquidæ.

*Oil of Tar.*—Oleum Picis Liquidæ, U. S.—Obtained by distillation of Tar, and

*Oil of Cade.*—Oleum Cadinum, U. S.—Obtained by destructive distillation of Juniper wood; are considered among the empyreumatic volatile oils.

*Creosote.*—Creosotum, U. S.—A mixture of several substances belonging to the class known as Phenols, obtained by distillation of wood-tar, preferably that from Beech, with a boiling point above 200°C., consisting chiefly of Guaiacol,  $C_7H_8O_2$  and Creosol,  $C_8H_{10}O_2$ . The distillate from tar separates into two layers, the heavier portion is freed from impurities by treating it alternately with caustic potash and sulphuric acid, and the portion boiling over 205°C. separated by fractional distillation.

An almost colorless oily liquid, becoming darker with age and upon exposure, of a penetrating, smoky odor and burning, caustic taste. Boils above 205°C., becomes gelatinous but does not solidify at the freezing point (difference from Carbolic Acid). It is inflammable, burning with a smoky flame and coagulates the albumen of the skin, thereby producing a white stain when applied to it.

It is of almost neutral reaction, sp. gr. about 1.070. Soluble in 150 parts of water, in somewhat less of hot water, soluble in all proportions in alcohol, ether, chloroform, fixed and volatile oils, benzin and carbon disulphide.

Creosote is largely adulterated with Carbolic Acid, from which it may be distinguished by the above physical properties and also certain tests noted under the latter.

*Uses.*—To deaden pain and preserve tissue as an application in tooth-ache. Internally to allay nausea and in larger doses, 1 C.C. per day, in solution in a fixed oil as a remedy in consumption and lung diseases.

*Off. Prep.*—Aqua Creosoti, a saturated solution.

## Coal-Tar Products.

By the destructive distillation of Coal, as in the burning of Coal in Gas-works, a series of compounds quite similar to those derived from wood are obtained. First, the gases which furnish the illuminating gas, Hydrogen, and its Carbon Compounds known as the Marsh Gas,  $\text{CH}_4$ , Series. Second, Liquids which comprise the Hydrocarbons, Benzol or Benzene or "Coal-tar benzin," Toluol, etc.; the *acid* constituents, Phenol, Cresol, etc., and a great variety of bases of the Ammonia type. Third, *solids*, Naphthalin, etc., and finally, fourth, the residue, *Coke*.

Of all of these substances only a few are official, although from nearly all of them valuable chemical and medicinal agents are obtained.

*Carbolic Acid.*— $\text{C}_6\text{H}_5\text{OH}$ .—Acidum Carbolicum, U. S.—This is not an acid but chemically a Phenol and this its correct chemical name. Obtained by distilling that portion of coal-tar known as "dead oil," and collecting what comes over between the temperatures of  $150^{\circ}\text{C}$ . and  $200^{\circ}\text{C}$ . After two rectifications this constitutes the crude Carbolic Acid of the U. S. Ph., a mixture of cresol and phenol.

The crude acid is treated with Caustic Potash, the crystals of carbolate of potassa are heated to  $170^{\circ}\text{C}$ . to char organic impurities, dissolved in water and the acid is set free, by supersaturation with Hydrochloric Acid, as an oily liquid. This is freed from water and finally obtained in crystals by condensing the distillate at the freezing point. Colorless, acicular crystals, or a crystalline mass, usually acquiring a reddish tint, having an aromatic odor and a sweetish, burning taste. Soluble in 15 parts of water, very soluble in alcohol, ether, chloroform, benzol, carbon disulphide, fixed and volatile oils. Soluble in glycerin, but almost insoluble in benzin (difference from creosote).

Carbolic acid resembles creosote in its odor, in its caustic properties, in its antiseptic power, and in many of its uses, but differs from it in chemical composition, in being a solid at ordinary temperatures, in having a lower boiling point, in its power to coagulate collodion when mixed with it, and in its far greater solubility in water.

Carbolic acid will remain permanently liquid if the crystals be melted by immersing the containing bottle in hot water, and then mixing water with the liquefied crystals in the proportion of one part of the former to nineteen of the latter. By using alcohol, instead of water, solution may be effected without the use of heat by simply placing the containing vessel "upside down," after the alcohol has been added.

*Uses.*—The most important uses of carbolic acid are as a disinfectant

**and antiseptic** As a dressing, carbolic acid is usually applied in the form of carbolated oil, or petrolatum. The lotion is prepared by dissolving one part of the acid in thirty of hot water. For internal administration, only the purest kinds should be dispensed. The dose is about 0.06 (1 grain) largely diluted.

*Off. Preps.*—Unguentum Acidi Carbol.; Glyceritum Acid. Carbol.

Care must be observed to distinguish between: The Solution of Carbolic Acid, a saturated solution, made by dissolving 5 per cent of the acid in water, and the *liquefied* Carbolic Acid, prepared by the addition of 5 per cent of water or alcohol, to the crystallized acid.

**Salicylic Acid.**— $\text{HC}_7\text{H}_5\text{O}_3$ .—Acidum Salicylicum, U. S.—A mono-basic acid existing naturally as Methyl Salicylate in Oil of Gaultheria, but made chiefly synthetically from Carbolic Acid.

It may be obtained by heating Oil of Gaultheria with Potassa until the liberated Methyl Alcohol is volatilized and decomposing the Potassium Salicylate thus formed with Hydrochloric Acid, which separates the Salicylic Acid in the form of crystals.

Commercially Salicylic Acid is made by treating Carbolic Acid with Sodium Carbonate and subjecting the Sodium Phenolate so formed to Carbon Dioxide, by which it is converted into Sodium Salicylate and decomposing this by Hydrochloric Acid, which sets the Salicylic Acid free.

Colorless, needle-shaped crystals, acid and slightly acrid to the taste; melting at 156°C., sublimes unaltered if carefully heated to 200 C. Soluble in 450 parts of water, in 2.4 parts of alcohol, in 2 parts ether and in 80 parts chloroform. Salicylic acid should be free from the odor of carbolic acid, and its solution in cold sulphuric acid should be colorless, or have only a slightly yellow color, showing the absence of organic impurities.

*Uses.*—Salicylic acid and its compounds, particularly the Salicylate of Sodium, are extensively used and of great value in acute articular rheumatism. The acid is also of much value as an antiseptic and preventive of fermentation.

**Sulpho-Carbolic Acid** is a mixture of equal parts of Carbolic Acid and Sulphuric Acid. It is used as an antiseptic and furnishes several salts.

**Salol.** U. S.—Phenyl Salicylate.—Is a compound of Phenol and Salicylic Acid. A white powder of faint aromatic odor, almost insoluble in water, soluble in 10 parts alcohol, very soluble in ether, chloroform, fixed and volatile oils.

*Uses.*—Chiefly as a remedy in rheumatism, dose 1 Gm.

**Phenacetin.**—By action of Sulphuric Acid on Phenol. A crystalline powder, almost insoluble in water (1500), soluble in 16 parts alcohol.

*Uses.*—Antipyretic and antiseptic, dose 0.3 to 1 Gm.

**Benzol.**— $\text{HC}_6\text{H}_5$ .—Benzene.—Phenyl Hydride.—Obtained from coal-tar by fractional distillation.

A colorless liquid boiling at 80 C., sp. gr. 0.878. A great solvent for fat, wax, resin, etc.

From Benzene a great many substances are produced, among which the following are the most important:

*Nitro Benzene*.— $C_6H_5NO_2$ .—Oil Mirbane.

*Anilin*.— $C_6H_5NH_2$ .—Phenylamine, “anilin oil.”

*Acetanilid*.— $C_6H_5NH.C_2H_3O$ .—Acetanilidum, U. S.

A crystalline powder soluble in 194 parts of water, in 5 parts of alcohol, 18 of ether, soluble in chloroform.

*Uses*.—As an antipyretic and analgesic; dose 0.3 to 0.6 Gm.

*Resorcin*.— $C_6H_4(OH)_2$ .—Resorcinum, U. S.

Faintly reddish crystals, very soluble in alcohol and water.

*Uses*.—As a non-poisonous antiseptic.

*Naphthalin*.— $C_{10}H_8$ .—Naphtalinum, U. S.—Obtained as an end-product in the fractional distillation of coal-tar.

Crystalline plates insoluble in water. Soluble in 15 parts alcohol, very soluble in ether, chloroform, fixed and volatile oils.

*Naphtol*.— $C_{10}H_7OH$ .—Naphtol, U. S.—Beta Naphtol.

Buff-colored, shining plates, phenol-like odor, almost insoluble in water (1000), very soluble in alcohol, ether, etc.

*Uses*.—As antiseptics and disinfectants.

#### PETROLEUM DERIVATIVES.

*Petroleum*.—Also known as Coal Oil, Rock Oil, Stone Oil, Seneca Oil, etc. A liquid mixture of Hydrocarbons with boiling points ranging from 30°C. to 300°C. and over. These may be separated by fractional distillation, among which the following are the most important:

*Rhigolene*.— $C_5H_{12}$ .—Boiling point 30°–45°C., lightest liquid known.

*Benzin*.— $C_6H_{14}$ .—Boiling point 50°–60°C., sp. gr. 0.67.

*Kerosene*, rectified petroleum freed from the preceding.

At a temperature above 300°C. paraffin comes over in the three stages of physical form; liquid, semi-solid and solid, according to the relative proportions of the liquid Hydrocarbons and the solid Paraffin, which they hold in solution. The product after purification is official in the following forms:

*Petrolatum Liquidum*, U. S.—Paraffine Oil.

*Petrolatum Molle*, U. S.—Soft Petrolatum-Petroleum Ointment.—Melting point between 40° and 45°C. (104°F.–113°F.). This is the product dispensed for Petrolatum, “Vaseline” and “Cosmolin.”

*Petrolatum Spissum*, U. S.—Hard Petrolatum.—Melting point between 45° and 51°C. (113°F.–125°F.).

*Uses*.—As vehicles for external medication. Not absorbable and should not be used instead of vegetable and animal fats, when medicinal action other than that exerted on the skin surface is required.

*Paraffin*, a wax-like substance is the end-product, and *asphalt* or bitumen the final residue.

## The Carbo-Hydrates.

The carbo-hydrates include the Starches, Sugars and Gums; cellulose and lignin being also sometimes classed with these.

They are closely related chemically, and agree in containing the Hydrogen and Oxygen in the same proportion in which these elements occur in the *water-molecule*, that is twice as much Hydrogen as Oxygen.

In the processes of vegetable life, all other substances appear to be produced either directly or indirectly from starch.

### STARCHES.

Starch appears to be the first product of the assimilative process in the plant, and is made directly from Water and Carbon Dioxide by the agency of chlorophyl and sunlight. It first makes its appearance in the chlorophyl bodies, where, by means of a good microscope, aided by appropriate tests, it may be discovered; it then passes into some soluble form, as glucose, dextrin, or some other of the many forms of *sugar*, and is carried in the sap of the various parts of the plant, and either again stored up as starch in the roots, seeds, etc., or converted into *fixed oils* for the future uses of the plant, or it is formed into cellulose, lignin, suberin, gum, or, by reactions with nitrates or ammonia compounds and sulphates, it is converted into *proteid* compounds.

Starch is, in other words, the formative material of the plant, from which, in the long run, all its tissues are built up.

It usually exists in the cells in the form of minute granules, in seeds, in roots and in the pith of some plants, as the Sago Palm also, in the leaves, bark, and even wood. The granules differ widely in shape and size, often so characteristic of certain species of plants that their source may be determined by microscopical examination. Usually the grains possess a nucleus or *hilum* which is sometimes centrally and sometimes eccentrically located, and around this nucleus concentric markings are frequently seen.

The starch grain is composed of about 95 per cent *granulose* and about 5 per cent *starch cellulose*. By digestion with saliva at 38 C., the granulose dissolves, leaving a perfect skeleton of the grain in starch cellulose, which acquires a yellowish coloration with Iodine while the granulose is stained a deep violet color.

*Starch*.—*Amylum*, U. S.—The fecula of the seed of *Zea Mays*, L., Indian Corn. It has the chemical formula  $C_6H_{10}O_5$  or some multiple

of this. The Starch is obtained by reducing the grain to coarse powder and washing with water to free the starch-grains from the seed coating and other adhering substances. After thoroughly washing, the starch is collected and dried.

In irregular masses or fine white powder, inodorous, tasteless, insoluble in neutral solvents but when boiled with water yields a white jelly with a bluish tinge. Owing to its staining effect, iodine is the best reagent for detecting the presence of starch.

*Off. Prep.*—Glyceritum Amyli, containing 10 per cent.

A large number of isomers of starch are known, among the more important of which are Dextrin, Lichenin, Inulin and Glycogen.

*Dextrin* is soluble in water, and does not react with iodine to produce a violet color. As found in the plant it probably represents transition stages in the process of change from starch to the sugars. It may be produced artificially by heating starch paste to a temperature of 260°C. Also by the action of Oxalic Acid, Nitric Acid, or Sulphuric Acid on Starch. Its solution is largely used as a mucilage.

*Lichenin* is the peculiar form of starch which is found in Iceland moss. It is soluble in hot water, but is precipitated from it again as a gelatinous mass on cooling.

*Inulin* replaces starch in the roots of Inula, Taraxacum, Cichorium, and other Compositæ. In its properties it stands between starch and sugar. It is slightly soluble in cold water, freely so in hot, and is soluble in absolute alcohol. It is not colored blue by iodine, and is very hygroscopic.

*Lævulin* is found associated with inulin in some of the Compositæ, and with ordinary starch in the young grain of Rye. It is amorphous, and deliquescent, and is soluble in dilute alcohol.

*Glycogen* is the peculiar form of starch found in the liver of man and many other animals. It is an amorphous white powder, soluble in water, and its aqueous solution is colored wine-red by iodine.

These starches form a group called the Amylum Group. They are all transformed by the action of acids into *glucoses*.

#### STARCH DRUGS OR STARCHES.

*Arrow Root*.—Maranta.—The Starch prepared from the root of Maranta arundinaceæ.

*Canna*.—From the rhizome of Canna edulis.

*Cassava*.—Brazilian Arrow Root, Tapioca meal, from the root of Manihot utilissima.

*Tapioca*.—From the above by drying on iron plates.

*Sago*.—The pith of Metroxylon Sagu, granulated and dried.

*Rice Starch*.—Amylum Oryzæ.—From the seed of Oryza sativa.

*Wheat Starch*.—Amylum Tritici.—From the seed of Triticum vulgare.

## SUGARS.

The Sugar Group consists of compounds closely related to the starches, but they are crystalline, sweet or sweetish to the taste, and more or less soluble in water. They are divided into two classes, the Saccharoses and Glucoses.

The *Saccharoses*, of which common cane sugar is the type, have the formula  $C_{12}H_{22}O_{11}$ . The principal members of the group are:

Cane sugar,              Milk sugar,              Maltose.

Melitose,              Trehalose,              Melezitose,

They are all characterized, optically, by deviating the plane of polarized light to the *right*, and chemically by being convertible by boiling with dilute sulphuric acid into *glucoses*. They differ also from the glucoses in *not* being directly fermentable.

## CANE SUGAR.

Cane sugar, the most important member of the group, is widely distributed in the vegetable kingdom, but its principal commercial sources are the Sugar Cane, the Sugar Beet, certain of the Palms, and the Sugar Maple. The sugar is contained in solution in the sap of these plants.

The process of obtaining it from the sap varies with the different sources, but consists essentially in the following:

(1) Getting rid of albuminoid impurities by treatment with Milk of Lime, or some other suitable substance.

(2) Concentration by evaporation and the separation of the crystallizable from the uncrystallizable portion.

(3) Refining the crude crystalline product by dissolving it, treating it with Animal Charcoal and albuminous substances, thus removing coloring matters and other impurities, then concentrating and crystallizing.

*Sugar*.—*Saccharum*, U. S.—The refined sugar of *Saccharum officinarum*, L., and from various species or varieties of *Sorghum*, also from the *Beta vulgaris*.

Pure cane sugar crystallizes in colorless crystals of sp. gr. 1.593. Soluble in one-half its weight of water, in 175 parts alcohol, in 28 parts boiling alcohol, but insoluble in ether, chloroform, etc. Its melting point is about 160 C.; when heated to a higher temperature it gradually undergoes change, and is converted into Caramel. More strongly heated, the caramel is decomposed, and a mass of porous charcoal is left behind.

Many compounds of sugar, with bases, are known, but only one, the saccharate of calcium, is of importance in pharmacy, under the name of *Syrupus Calcium*, U. S. Ph.

*Uses*.—For the production of Syrups, Elixirs, and many Mixtures both solid and liquid. As a preservative, diluent and excipient in Pill-Masses, Confections, Troches, etc.

*Eleosacchara*, or Oil Sugars, are mixtures of some volatile oil with sugar, 1 drop to 30 grains, N.F.

Other Saccharoses are the following:

*Milk Sugar*.—*Saccharum Lactis*, U. S.—Occurs in the milk of mammalia, particularly in cow's milk. It is prepared from whey by evaporating it to a syrup, allowing it to stand and crystallize, and then purifying by decoloration and re-crystallization.

Crystalline, less sweet to the taste than cane sugar, sp. gr. 1.534, soluble in 6 parts of cold and in 1 part of boiling water, insoluble in alcohol, ether or chloroform.

*Uses*.—Valuable as a diluent and as such used for the official class of preparations, the *Triturations*.

*Melezitose* is a peculiar sugar found in certain mannas, particularly *Abies larix*.

*Melitose* forms the principal constituent of the manna that exudes from *Eucalyptus manifera* and some other species of the same genus. It is in the form of fine felted needles, which contain three molecules of water of crystallization.

*Trehalose*, sometimes called mycose, occurs in ergot of rye, in *Agaricus sulphureus*, and several other fungi.

*Maltose* is a peculiar sugar obtained by treating starch paste with malt. It crystallizes in fine needles.

#### GLUCOSSES.

The glucoses, of which common grape-sugar, or Dextrose, is the type, have the formula  $C_6H_{12}O_6$ .

They differ from the saccharoses in being *directly fermentable*, and in having the power to reduce *cupric* tartrate (in the alkaline volumetric solution, known as Fehling's) to *cuprous* oxide; manifested by the formation of a brick-red precipitate upon heating a mixture of these. The more important are:

Dextrose, or grape sugar.		Galactose.
Levulose, or fruit “		Arabinose, and Inosite.

*Dextrose*, so-called because it rotates the plane of polarization to the right, is widely distributed in the vegetable kingdom, often occurring associated with cane, fruit and other sugars. It was first obtained from grapes, and hence is called grape-sugar. It is now manufactured on a large scale from Starch, by the action of Dilute Sulphuric Acid upon it. The process takes place in two stages: Dextrin being first produced, and then afterward, by the continued action of the acid and heat, this is converted into glucose.

*Commercial* liquid Glucose is a dense syrup consisting of true glucose, maltose and dextrin in varying proportions with water. Besides being used somewhat in pharmacy to increase the body of syrups without producing a corre-

sponding increase in sweetness, it is used extensively by brewers in the manufacture of sparkling ales, etc., and in the adulteration of table syrups.

*Solid Glucose* is in whitish, crystalline, anhydrous masses, much less sweet than cane sugar for which it is sometimes substituted.

*Levulose* is found associated with grape-sugar in fruits, and is commonly called fruit-sugar. It differs optically from dextrose or grape-sugar, by rotating the plane of polarization to the left instead of the right. It is a colorless, uncrystallizable syrup, and is nearly as sweet as cane sugar. It is obtained from inulin by treating it with dilute sulphuric acid.

*Galactose* is a peculiar sugar derived from milk sugar by the action of dilute sulphuric acid. It rotates the plane of polarization to the right.

*Arabinose* is a sugar obtained by boiling gum arabic in dilute sulphuric acid. It differs but little from galactose.

*Inosite* was first found in muscles of animals, and hence is called muscle sugar; but it is now known to occur also in some plants. It is crystalline, sweet, soluble in about 6 parts of water, and insoluble in alcohol.

*Manna*.—Manna, U. S.—A sweet substance formerly regarded as a sugar, a concrete saccharine exudation of *Fraxinus Ornus*, L., a species of Ash growing in Southern Europe. In flattish pieces, friable, externally yellowish-white, internally white, porous and crystalline, odor honey-like, taste sweet, slightly bitter and faintly acrid.

*Mannite* is prepared by dissolving manna in half its weight of boiling water, clarifying the solution with white of egg, filtering it while hot and crystallizing. The crystals are separated from the mother liquor by draining or by pressure, dissolved in a small quantity of water, treated with animal charcoal, filtered, and crystallized.

*Uses*.—A gentle laxative and cholagogue; an ingredient in Infusum Sennæ Comp.

*Honey*.—Mel, U. S.—A saccharine secretion deposited in the honey-comb by *Apis mellifica*, L., the Honey Bee.

Consisting of two kinds of sugar in nearly equal proportion, dextrose, the more solid portion prone to granulation and levulose, or fruit-sugar, the liquid portion.

A syrupy liquid of light-yellowish color, translucent when fresh, but gradually becoming opaque and crystalline, of an aromatic odor and a sweet, faintly acrid taste.

*Purified Honey*.—Mel Despumatum, U. S.—Honey in which the impurities have been removed by coagulation with heat, clarification by straining through paper pulp, and granulation prevented by the addition of 5 per cent of Glycerin.

*Uses*.—As an excipient in masses and confections.

*Off. Prep.*.—Mel Rosæ, containing 10 per cent of Rose.

## GUMS.

The Gums are bodies closely related in their chemical structure to starch and cellulose,  $C_6H_{10}O_5$ , some containing an additional molecule of water. They are common vegetable products.

Exuding from many plants when the bark is punctured, they appear to perform the function of plugging up the wounded vessels and facilitating the healing process. These are produced, mostly at least, by the transformation of the cellulose or the substance of the cell-walls of plants.

Some are soluble in water, others only swell up but do not properly dissolve, and by reason of this difference they may be divided into two groups, only one representative of each, however, being official:

*Acacia*.—*Acacia*, U. S.—*Gum Arabic*.—A gummy exudation derived from *Acacia Senegal*. The greatest portion of a good quality of gum arabic consists of arabin or arabic acid, which may be prepared from the aqueous solution of the gum by acidulating it with chlorhydric acid and adding alcohol.

In roundish tears or angular fragments with a glass-like fracture, nearly inodorous, taste pleasantly acid, slowly soluble in 2 parts of water, forming a thick, viscid solution or mucilage; insoluble in alcohol. Its solution is coagulated by borax and also by lead subacetate solution into a light-yellow mass, and by ferric chloride into a reddish jelly; boiled for some time with dilute sulphuric acid, it is converted into glucose.

*Uses*.—It is employed extensively in the arts for a variety of purposes, as in the manufacture of mucilage, in the preparation of water-colors, in the preparation of ink, in order to hold in suspension the fine particles of tannate of iron; and in pharmacy it is used in the preparation of emulsions, pill-masses, pastes, syrups, etc.

*Off. Prop.*.—*Mucilago Acaciæ*, containing 34 per cent by weight; *Mist Glycyrrh. Comp.*; *Syrupus Acaciæ* and the powdered in *Pulvis Cretæ Compositus*, *Emulsions*, *Troches*, *Pills*, etc., as an excipient.

*Tragacanth*.—*Tragacantha*, U. S.—*Gum Tragacanth*.—An exudation from the stem of *Astragalus gummifer* and other species of *Astragalus*. It consists largely of bassorin, which swells up but does not dissolve in water and is tinged blue by iodine.

In bands more or less curved, translucent, tough, rendered friable by heat.

*Uses*.—The Mucilage without the addition of glycerin as a paste, the Glycerite as an excipient, and the powder as a "binding medium" in many Mixtures and as an Emulsifying agent.

*Off. Prop.*.—*Mucilago Tragacanthæ*, containing 6 per cent.

*Cerasin*, found in the gummy exudation from cherry trees, resembles tragacanth in its properties.

# Drugs of Group I.

In this group will be included Drugs which owe their value chiefly to Starch, Sugar or Gum.

*Barley*.—*Hordei Fructus*.—The seed of *Hordeum distichum*, L. Constituents: Starch, Gluten, etc. For preparing demulcent drinks.

*Malt*.—*Maltum*.—Seed of *Hordeum distichum*, Linne, caused to begin germination and then dried. Constituents: Dextin, diastase, sugar, starch, etc. Preparation: Extractum Malti.

*Diastase*, a peculiar ferment, during the process of malting converts part of the starch into dextrin and sugar, and subsequently when the malt is "mashed," in brewing and in preparing malt extract, all the starch is converted into these compounds by the action of the diastase, which sets in at a certain temperature. Diastase is destroyed at a high temperature, hence the necessity of not exceeding 70°C. in the process of conversion.

*Oat Meal*.—*Avenæ Farina*.—The grain of *Avena sativa*, L., ground into a meal. Used for dietetic purposes, gruel, etc.

## SACCHARINE DRUGS.

*Corn Silk*.—*Zea*, U. S.—The styles and stigmas of *Zea Mays*, Linne, Indian Corn. Constituents: Sugar, fixed oil, resin, tannin and an acid. Off. Prep.: Ext. Fl.

*Fig*.—*Ficus*, U. S.—The fruit of *Ficus Carica*, Linne. Constituents: Sugar, gum, etc. Off. Prep.: Confectio Sennæ.

*Prune*.—*Prunum*, U. S.—Fruit of *Prunus domestica*, Linne. Constituents: Sugar, pectin, etc. Off. Prep.: Confectio Sennæ.

*Triticum*.—*Triticum*, U. S.—Couch Grass.—Rhizome of *Triticum repens*, Linne. Constituents: Sugars, tritiein (similar to inulin). Off. Prep.: Ext. Fl.

## MUCILAGINOUS DRUGS.

Some of these drugs also contain a valuable fixed oil.

*Sweet Almond*.—*Amygdala dulcis*, U. S.—Seeds of *Prunus Amygdalus*, var. *dulcis*, De Candolle. Constituents: Fixed oil about 50 per cent, mucilage, sugar, etc. Off. Prep.: Emulsum Amygdalæ; Syrupus Amygdale.

*Uses*.—For obtaining *Oleum Amygdalæ Express.*: Emulsion used as a vehicle for other substances; and as flour or paste for cosmetic preparations.

*Althæa*.—*Althæa*, U. S.—Marshmallow.—Root of *Althæa officinalis*, Linne. Constituents: Starch 37 per cent, mucilage, asparagin, etc. Off. Prep.: Syrupus Althææ.

*Uses.*—Owing to the large proportion of starch it contains, preparations of althaea must always be prepared without the use of heat in the extraction (see infusion). The root occurs in commerce in the form of small cubes, and as such is largely used as an ingredient in Species Pectorales P. Ger.; also for preparing a demulcent drink. The powder, owing to its absorbing qualities, is largely used in pill-masses.

*Cetraria.*—*Cetraria*, U. S.—Iceland Moss.—Entire plant of *Cetraria Islandica*, Acharius. Constituents: Lichenin or lichen starch, 70 per cent, cetraric acid, etc. Off. Prep.: Decoctum *Cetrariæ*.

*Uses.*—In the preparation of Iceland moss jelly, it is desirable to free the moss from the cetraric acid, to which the bitter taste is due, by macerating it in tepid water for half an hour, expressing the liquid which is rejected; and then exhausting the moss by boiling water, and straining. To the strained liquid sugar is added, and the mixture evaporated to jelly consistence. .

*Chondrus.*—*Chondrus*, U. S.—Irish Moss.—Plant of *Chondrus crispus*, Stackhouse. *Gigartina mamillosa*, Greville. Constituents: Mucilage, and traces of iodides, bromides, sulphates. Does not contain starch.

*Uses.*—Chiefly in the form of a mucilage as an emulsifying agent. The decoction of Irish moss and Carrageen jelly are both prepared similarly to those from cetraria.

*Cydonium.*—*Cydonium*.—Quince seed, Seed of *Cydonia vulgaris*, Persoon. Constituents: Mucilage. Prep.: *Mucilago Cydonii*.

*Uses.*—Mostly as a demulcent in the form of mucilage. Also largely as a hair dressing; the mucilage having but little adhesive power renders it sometimes preferable to tragacanth for that purpose.

*Elm.*—*Ulmus*, U. S.—Slippery Elm.—Inner bark of *Ulmus fulva*, Michaux. Constituents: Mucilage. Off. Prep.: *Mucilago Ulmi*.

*Uses.*—Somewhat as a demulcent, but chiefly for poultices, when it should be coarsely ground so that the mass will adhere together when moistened with water.

*Flax Seed.*—*Linum*, U. S.—Seeds of *Linum usitatissimum*, Linne. Constituents: Mucilage, fixed oil about 40 per cent.

*Uses.*—Ground flaxseed, "Lini Farina," for poultices. When deprived of oil, it is termed "oil cake," which is said to make an excellent cataplasm. From the whole seeds "flaxseed tea" is prepared, and with the addition of liquorice and a little lemon juice, furnishes a refreshing draught.

*Sassafras Pith.*—*Sassafras medulla*, U. S.—Pith of *Sassafras variifolium*, Kunze. Constituents: Mucilage. Off. Prep.: *Mucilago Sassafras*.

*Uses.*—In the preparation of Jackson's Pectoral Syrup; for collyria, and as a vehicle for more active remedies.

# Products by Fermentation.

Starch and its derivatives, Albumen, etc., subjected to the effects of heat and water, in the presence of bodies called *ferments* undergo certain transformations by which their physical, as well as chemical, characters are more or less completely changed.

These so-called Ferments may be either *organized*, microscopic plants, such as the *Torula Cerevisiae*, the common "Yeast plant;" the *Mycoderma aceti*, the "Vinegar plant;" or they may be simply *nitrogenized* or albuminoid substances, such as *Diastase* from Malted Grain or *Pepsin* and *Pancreatin* derived from Animals.

Since there are different Ferments, so there are also different kinds of *Fermentations*, viz.: The *saccharine* fermentation, in which Starch or Sugar is converted into *glucose*; the *alcoholic* or "vinous" fermentation, by which Glucose is converted into *Alcohol*, and the *Acetic* fermentation, by which Alcohol is converted first into Aldehyde and afterward into *Acetic Acid*.

There are, besides, the *lactic*, *butyric* and other kinds of Fermentation, not to mention the more complex bodies, such as *Emulsin*, that produce so many wonderful phenomena in both animal and vegetable life.

The Alcoholic fermentation is of the greatest pharmaceutical interest and will be here considered.

## THE ALCOHOLIC FERMENTATION.

As has already been stated, Starch, in the form of Corn or other grain, may be converted into glucose by heat and other agencies. Glucose differs from the other kind of sugar, saccharose, chiefly in that it is *directly fermentable*. When, therefore, a *ferment* is added to glucose it is broken up into carbon dioxide and Alcohol, which may be obtained in a more or less pure form by distillation.

The steps in the process are as follows:

The grain, after being ground to a meal, is macerated with water at 88°C., known as the operation of "mashing," through which the Starch is changed into a soluble form, dextrose, etc., or *maltose*. Upon the addition of Malted Barley or Rye, the Maltose, at a temperature of 60°C., is converted by the Diastase into *glucose*.

To this liquid, cooled to 18°C., Yeast is added, when the Glucose is broken up into Carbon Dioxide, which escapes, and *Alcohol* remaining in the liquid.

Other products are also formed at the same time, being chiefly alcohols of different chemical composition, such as *Amylic Alcohol* or Fusel Oil and *Propenyl Alcohol* or Glycerin.

These latter are much less volatile, that is, have a much higher boiling point, than the ordinary alcohol, and therefore are largely left behind when the liquid is distilled in order to obtain the Alcohol in a pure form.

## FORMS OF ALCOHOL.

In the operation of recovering the Alcohol by distillation it may be obtained in various degrees of strength and purity.

*High Wine* or "Crude Whisky" is the first distillate obtained, containing alcohol and water in nearly equal proportions. Its strength is designated by the number of degrees proof by the U. S. Internal Revenue Bureau; *two degrees proof* being equal to *one per cent by volume* of Absolute Alcohol.

Thus an alcohol of equal parts by volume of Absolute Alcohol and Water, at a temperature of  $15.667^{\circ}\text{C}$ . ( $60^{\circ}\text{F}$ .) is 100 proof, and on this the tax to be paid is \$1.10 for one U. S. Wine Gallon. An alcohol  $188^{\circ}$  proof contains, therefore, 94 per cent absolute alcohol, by volume.

The strength of alcohol is best determined by a Custom House *alcoholometer* and may readily be transcalculated into percentage by weight or specific gravity by reference to the alcohol Tables, p. 531, U. S. Ph. For the simplest method of reducing or increasing the strength of alcohol of various percentages, refer to rules U. S. Ph., p. 30.

*Alcohol*, U. S.—Alcohol, U. S.—A liquid composed of about 91 per cent by weight, or 94 per cent by volume, of Ethyl Alcohol,  $\text{C}_2\text{H}_5\text{OH}$ , and about 9 per cent by weight, or 6 per cent by volume of Water; sp. gr. at  $15^{\circ}\text{C}$ . 0.820.

Obtained by fractional distillation from high wine or by direct distillation, separation of most of the water being effected by the use of upright or column condensers.

A transparent, colorless, mobile liquid of a characteristic agreeable odor and a burning taste. Miscible in all proportions with water, ether and chloroform. A ready solvent for most of the volatile oils, camphors, etc., resins and a great variety of organic and many inorganic compounds. Does not dissolve nor mix with fixed oils or fats with a few exceptions. It boils at  $78^{\circ}\text{C}$ ., is very inflammable, burning with a blue flame. Organic impurities are detected through coloration with silver nitrate solution. Alcohol should be kept in well-closed vessels remote from light or fire.

*Uses*.—As the most valuable and largely employed solvent, next to water; for preparing the three other official forms of alcohol and for producing many chemical compounds.

*Dilute Alcohol*, U. S.—Alcohol Dilutum, U. S.—A liquid composed of about 41 per cent by weight (48.6% vol.) of Absolute Alcohol and 59 per cent by weight of Water; sp. gr. at  $15^{\circ}\text{C}$ . 0.936. Prepared by mixing equal volumes of Alcohol and Distilled Water.

In mixing alcohol and water a contraction occurs, which with equal volumes amounts to nearly 3 per cent in the mixed liquids.

*Deodorized Alcohol*, U. S.—Alcohol Deodoratum, U. S.—Cologne Spirit.—Composed of 92.5 per cent by weight (95.1% vol.) of Alcohol

and 7.5 per cent by weight (5% vol.) of Water; sp. gr. at 15°C., 0.816. Prepared from alcohol by filtration through animal charcoal; rectification from Potassium Permanganate or other oxidizing agents.

*Uses.*—Free from the odor of "raw" alcohol due to fusel oil etc., this kind of alcohol should be used for Flavoring and Perfume purposes.

*Absolute Alcohol.*— $C_2H_5OH$ .—Alcohol Absolutum, U. S.—Ethyl Alcohol containing not more than 1 per cent by weight of water; sp. gr. 0.800 (0.797) at 15°C. It is freed from water by rectification over Lime.

It is very hygroscopic and must be kept in tightly stoppered bottles in a cool place.

*Uses.*—As a chemical reagent and solvent.

*Whisky.*—Spiritus Frumenti, U. S.—An alcoholic liquid obtained by the distillation of the mash of fermented grain, usually mixtures of Indian corn, wheat and rye, and at least two years old.

Its sp. gr. should not be more than 0.930 nor less than 0.917, corresponding to an alcoholic strength of 44 to 50 per cent by weight (50-58% vol.). The distillate is colored by being allowed to stand in casks or barrels for a number of years, during which it undergoes changes that improve its quality. Whisky thus mellowed by age is called old whisky.

#### OTHER ALCOHOLS.

*Amyl Alcohol.*— $C_5H_{11}OH$ .—Or Fusel Oil.—Obtained as a by-product in the fermentation of grain. As it boils at a much higher temperature than alcohol, most of it comes over as the last product in the rectification of ordinary alcohol. Thus obtained it contains a considerable percentage of ordinary alcohol, which is separated by washing it with water, and then distilling over calcium chloride.

A thin, oily liquid, of an oppressive, penetrating odor, and an acrid, hot taste, boils at 132°C., sp. gr. 0.818. It is sparingly soluble in water, and freely so in alcohol, ether and benzol.

*Uses.*—Solvent for some of the alkaloids, source of valerianic acid and of various compound ethers which are used in flavoring and in perfumery.

*Propenyl Alcohol.*— $(C_3H_5)_3HO$ —Glycerin.—Is treated under Fats.

# Alcohol Derivatives.

These comprise the Ethers, Aldehyde and its derivatives, Chloral and Chloroform.

## THE ETHERS.

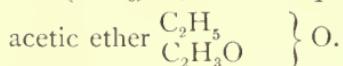
These ethers are the products of the action of Acids upon the Alcohols, and, as there are *series* of alcohols, so there are also of ethers.

They bear the same relation to the alcohols that the *oxides of the metals* bear to the *hydrates*. For example:

$(C_2H_5)HO$  is ethyl alcohol, or ethyl hydrate, and  $(C_2H_5)_2O$  is ether or ethyl oxide, so

$Na(HO)$  is sodium hydrate, and  $Na_2O$  is sodium oxide.

Ethers are of various kinds: some *simple*, as ethyl ether  $(C_2H_5)_2O$ ; some *haloid*, that is, built on the plan of a molecule of common salt, as chlorhydric ether  $(C_2H_5)Cl$ ; some *compound*, as



There are also several other kinds, of less pharmaceutical interest.

The common ethers are liquid, highly volatile and inflammable, but there are others which are dense, non-volatile, or even solid at ordinary temperatures.

The ethers of most importance in pharmacy are:

Simple . .	{ methyl oxide, $(CH_3)_2O$ , or methylic ether. ethyl oxide, $(C_2H_5)_2O$ , or ethylic ether.
Haloid . .	{ Ethyl chloride, $(C_2H_5)Cl$ , or chlorhydric ether. “ bromide, $(C_2H_5)Br$ , or bromhydric ether. “ iodide, $(C_2H_5)I$ , or iodothydric ether.
	ethylene bichloride, $(C_2H_4)Cl_2$ , or Dutch liquid.
Compound	{ acetic ether, $(C_2H_5)(C_2H_3O_2)$ , or ethyl acetate. formic “ $(C_2H_5)(CHO)O$ , or ethyl formate. nitrous “ $(C_2H_5)NO_2$ , or ethyl nitrite.

*Ether.*—Æther, U. S.—A liquid composed of 96 per cent by weight of absolute Ether or Ethyl Oxide  $(C_2H_5)_2O$  and about 4 per cent of Alcohol containing a little water. It is produced by reaction upon Alcohol with Sulphuric Acid, the Ether being obtained by distillation. The name “Sulphuric Ether” was given to it erroneously.

A colorless, transparent, highly refractive, volatile and inflammable liquid, of a pleasant, penetrating odor, and sweetish pungent taste, sp. gr. 0.725 at

15°C., boiling point about 37°C. Its vapor mixed with air forms a highly explosive compound, and hence it should be handled with care and be kept in well-stoppered containers, remote from light or fire.

*Spiritus Etheris*, U. S., is a mixture of 32.5 C.C. ether with 67.5 C.C. of alcohol.

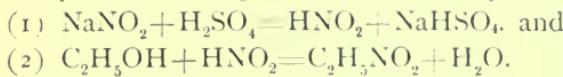
*Spiritus Etheris Compositus*, U. S., or Hoffmann's Anodyne, the above with 2.5 C.C. of ethereal oil in 100 C.C.

This and the preceding spirit are used in medicine as stimulants, antispasmodics, and anodynes.

*Uses.*—The great value of ether in pharmacy depends on its solvent power. It stands next to alcohol in this respect, and excels it as a solvent for certain oils and resins. In medicine its most important use is as an anæsthetic. It is safer and better than chloroform.

#### COMPOUND ETHERS.

*Nitrous Ether*.— $C_2H_5NO_2$ , or Ethyl Nitrite.—Formed along with other products when Alcohol is acted upon by Nitric Acid or Nitrites in the presence of sulphuric acid as a dehydrating agent:



A mobile, colorless liquid, with a peculiar pungent taste, and an odor resembling apples.

*Spirit of Nitrous Ether*.—*Spiritus Etheris Nitrosi*, U. S.—Sweet Spirit of Nitre.—An alcoholic solution of the above ether freshly prepared representing not less than 11 times its volume of Nitrogen Dioxide, NO, corresponding to about 4 per cent of Ethyl Nitrite. The Ether is produced by reaction on Sodium Nitrite with Sulphuric Acid in the presence of Alcohol and obtaining the Ether by distillation, purifying it and mixing it with 21 times its weight of Deodorized Alcohol.

A transparent, volatile, inflammable liquid with a pungent taste and a fruity odor; sp. gr. from 0.823 to 0.825 and its boiling point 65°C.

*Uses.*—As a diuretic and nervous stimulant.

*Acetic Ether*.— $(C_2H_5)(C_2H_3O_2)$ .—Ethyl Acetate.—Ether Aceticus, U. S.—A liquid composed of 98.5 per cent by weight of Ethyl Acetate and about 1.5 per cent of Alcohol. It is produced by reacting upon Sodium Acetate with Sulphuric Acid in the presence of Alcohol and distilling.

A limpid, colorless, volatile liquid, having an ethereal, and somewhat acetic odor and taste; inflammable; sp. gr. 0.895, boils at about 76°C.

*Uses.*—Similar to those of ether. It is also valuable as a solvent for many fixed and volatile oils and resins; and as an addition to perfumes.

*Formic Ether*.— $(C_2H_5)(CHO)O$ , or Ethyl Formate, is produced by distillation of a mixture of Sodium Formate, Alcohol and Sul-

phuric Acid, the distillate being afterward rectified over calcium chloride.

A limpid, colorless, inflammable liquid, with an agreeable smell, suggesting that of peach kernels, and a pungent taste. Sp. gr. 0.918, boils at  $70^{\circ}\text{C}$ .

*Uses.*—As a mild anæsthetic.

*Methylic Ether.*— $(\text{CH}_3)_2\text{O}$ .—Obtained by action on Methylic Alcohol with Sulphuric Acid and distilling.

A colorless, volatile, inflammable liquid at the temperature of  $20^{\circ}\text{C}$ ., but at higher temperature a gas which is freely soluble in water, ordinary ether, methyl alcohol, and alcohol. Like ordinary ether it has anæsthetic properties. Its uses in pharmacy are limited.

*Methyl Salicylate.*— $\text{CH}_3\text{C}_7\text{H}_5\text{O}_3$ .—Methyl Salicylas, U. S.—Artificial Oil of Wintergreen. Produced synthetically by the action of Salicylic Acid on Methylic Alcohol in the presence of Sulphuric Acid. Sp. gr. 1.183 to 1.185 at  $15^{\circ}\text{C}$ .

A colorless, slightly yellowish liquid having the characteristic odor and sweetish, aromatic taste of Oil of Gaultheria, being identical with the essential constituent of the latter (see Salicylic Acid). It is also identical with the volatile Oil of Birch. It boils at  $220^{\circ}\text{C}$ . and is soluble in all proportions in alcohol, glacial acetic acid and carbon disulphide.

*Uses.*—As a substitute for Oil of Gaultheria and medicinally for the same purposes as the other salicylates.

#### HALOID ETHERS.

*Ethyl Chlorides.*— $(\text{C}_2\text{H}_5)\text{Cl}$ , or Chlorhydric Ether, is produced by the action of Phosphorus pentachloride on ordinary Alcohol.

A colorless, mobile, volatile and inflammable liquid; burning taste; boils at  $13^{\circ}\text{C}$ ., sp. gr. 0.900.

*Ethylene Bi-Chloride.*— $(\text{C}_2\text{H}_4)\text{Cl}_2$ , is allied to the foregoing. It is commonly called "Dutch liquid," and is produced by the reaction of Chlorine gas upon olefiant gas.

A colorless, thin, oily liquid, with an odor like chloroform, a sweetish, pungent taste, inflammable, sp. gr. at  $0^{\circ}\text{C}$ ., 1.27, boils at  $85^{\circ}\text{C}$ .

It has been used as an anæsthetic.

*Ethyl Bromide.*— $(\text{C}_2\text{H}_5)\text{Br}$ , or Bromhydric Ether, is produced by the reaction of Bromine on Alcohol in the presence of phosphorus.

In physical properties it somewhat resembles ethyl chloride, but is denser, having a sp. gr. at  $15^{\circ}\text{C}$ . of 1.419; boiling point  $40^{\circ}\text{C}$ . It is also less readily inflammable.

Used as an anæsthetic, but the dangers attending its use are similar to those of chloroform.

*Ethyl Iodide*.— $(C_2H_5)I$ , or Iodothydric Ether, is prepared by a method analogous to that adopted in the preparation of ethyl bromide.

A colorless, non-inflammable volatile liquid of a peculiar, penetrating odor; sp. gr. 1.93 at 15°C., boils at 72°C.

Used for its iodine, as an inhalant in pulmonary disorders; not anæsthetic.

*Ethereal Oil*.—Oleum Aethereum, U. S.—A liquid consisting of equal volumes of Heavy Oil of Wine and Ether; sp. gr. 0.910.

Produced by the reaction of Sulphuric Acid on Alcohol, distilling, washing and mixing the distillate with an equal volume of Ether.

*Uses*.—For preparing Spiritus Aetheris Compositus.

#### AMYL DERIVATIVES.

*Amyl Nitrite*.— $C_5H_{11}NO_2$ —Amyl Nitris, U. S.—A liquid containing 80 per cent of Amyl Nitrite together with some other compounds. Sp. gr. 0.870 to 0.880 at 15°C. Produced by the action of Nitric or Nitrous Acid on Amylic Alcohol, the liquid distilled and purified by washing and rectification.

A pale, yellow liquid of a peculiar, faintly ethereal odor and pungent, aromatic taste. Almost insoluble in water, but miscible with alcohol or ether in all proportions. It volatilizes at ordinary temperature and is inflammable.

*Uses*.—The vapors as an inhalant to increase the heart's action. Dose 0.1 to 0.3 in glass-pebbles, to be crushed in a handkerchief for inhalation.

## ALDEHYDE AND DERIVATIVES.

*Aldehyde.*— $C_2H_4O$ .—Ethylic Aldehyde.—Produced by the oxidation of Alcohol by withdrawal of 2 atoms of H from  $C_2H_5OH$ , hence the name meaning Alcohol *de-hydrogenated*.

A colorless, mobile liquid, very inflammable, boils at  $21^{\circ}C.$ , miscible with water, alcohol and ether in all proportions.

*Paraldehyde.*— $C_6H_{12}O_3$ .—Paraldehydum, U. S.—A polymeric form of Ethylic Aldehyde.—Produced by the action of Chlorine on Ethylic Aldehyde until the latter is not soluble in an equal volume of water, when it is separated in a crystalline mass at the freezing point and afterward distilled.

A colorless liquid, boiling at  $123^{\circ}C.$ , soluble in 8.5 parts water and miscible with alcohol, ether, fixed and volatile oils in all proportions.

*Uses.*—As a hypnotic in the form of pearls, elixirs, etc.; dose 1 Gm.

*Chloral Hydrate.*— $C_2HCl_3O + H_2O$ .—Chloral, U. S.—A crystalline solid, composed of trichloraldehyde or Chloral with one molecule of water.

It is obtained by passing dry Chlorine gas into *absolute* Alcohol for a long time. The Alcohol is first decomposed into *Aldehyde* and the Chlorine into  $HCl$  and finally by the prolonged action of more Chlorine into Chloral. [See Reaction under Chloroform.] A solid mass is thus obtained which is treated with sulphuric acid, and the chloral separates as an oily layer. This is purified by distillation over quicklime, and hydrating the product by adding the necessary amount of water.

Rhomboidal, colorless and translucent crystal, having an aromatic, penetrating and slightly acrid odor and a bitterish, caustic taste; slowly volatilized when exposed to the air. Freely soluble in water, alcohol, ether, chloroform, benzol, benzin, fixed and volatile oils.

It liquefies camphor, menthol, thymol, phenol and their derivatives when triturated with them in about equal proportions.

*Uses.*—As a hypnotic, but is attended with some danger; as an overdose may produce fatal consequences, great care should be used in dispensing it, and only such samples as answer the Pharmacopeial tests for purity should be dispensed for internal use, namely, the crystals. Dose 0.5 to 1 Gm.

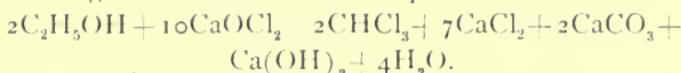
*Caution.*—Chloral is incompatible with alkalies and alkaline carbonates and compounds of Ammonium and Mercury.

*Chloroform.*— $CHCl_3$ .—Chloroformum, U. S.—Chloroformum Purificatum, U. S. Ph., '80.—A liquid consisting of 99 to 99.4 per cent by weight of Absolute Chloroform and 1 to 0.6 per cent of Alcohol; sp. gr. 1.490.

Its molecule is like that of methyl hydride,  $CH_4$ , except that three

of its hydrogen atoms are replaced by chlorine, and it belongs, therefore, chemically to the methyl series of compounds.

Produced by the action of Chlorinated Lime on Alcohol and distilling, also by the action of caustic Soda on Chloral Hydrate. The reaction leaving out the intermediate steps is as follows:



It is usually made by distilling Acetone with a mixture of Chlorinated Lime and Water. The distillate, washed with water, constitutes crude chloroform, which is of value in pharmacy as a solvent and in the preparation of liniment, but should never be used internally. The commercial chloroform is purified with Sulphuric Acid, which destroys the organic impurities, thoroughly washed and distilled with a little Alcohol to preserve it.

A heavy, clear, colorless liquid of a characteristic pleasant ethereal odor, a burning sweet taste and neutral reaction. It is soluble in about 200 times its volume of cold water and in all proportions in alcohol, ether, benzol, benzin, fixed and volatile oils. It is volatile at ordinary temperature, and boils at 60 C.

*Tests.*—When agitated with twice its volume of water, the latter should be (1) neutral to blue litmus-paper (absence of acids), (2) should not affect test-solution of silver nitrate (chlorides), nor (3) show coloration with Sulphuric Acid (organic impurities). No foreign odor should be noticed when a few drops are permitted to evaporate from a piece of blotting-paper. (For further tests see U. S. Ph.)

*Uses.*—Chiefly as an anæsthetic. It is doubtless less safe than ether, but most of the accidents that happen from its proper use as an anæsthetic may be attributed to the impure quality of the chloroform, and it cannot, therefore, be too strongly insisted upon that the tests of purity required by the Pharmacopœia be carefully applied to all chloroform sold for this purpose.

*Off. Prep.*—Aqua Chloroformi; Emulsum Chloroformi; Linimentum Chloroformi; Spiritus Chloroformi.

*Croton Chloral.*— $\text{C}_4\text{H}_5\text{Cl}_3\text{O}$ .—Butyl Chloral.—Trichlor-butyl-aldehyde.—By the action of Chlorine on Acetic Aldehyde, separation by distillation and hydration, as in making ordinary chloral.

It differs from ordinary Chloral, chiefly in being sparingly soluble in water. Its medicinal properties are the same as of the ordinary Chloral, in about one-third the dose.

*Iodoform.*— $\text{CHI}_3$ .—Tri-iodo-methane has been described under Iodine.

# Products of Vinous Fermentation.

## WINES.

Wines are alcoholic liquids produced by the fermentation of fruit juices, chiefly those of the different species of the Grape, *Vitis vinifera*. They may be divided into *white* and *red* wines.

The *White* wines are not usually colorless, but light-colored and are produced by the fermentation of the juice freed from seeds, stems and skins. The *Red* wines are reddish in color, because the juice is derived from colored grapes and has been fermented in contact with the "skins," and has consequently taken up more or less of their coloring matter, and therefore contains more tannin than the white wines.

*Vinum Album*, U. S., refers to any one of the numerous varieties of white wines of domestic production.

White wine should have a full, fruity, agreeable taste, without either excessive sweetness or acidity, and its odor should be agreeable and free from yeastiness. It should contain not less than 10 per cent, nor more than 14 per cent by weight of absolute alcohol, and its sp. gr. should be not less than 0.99 nor more than 1.01. Sherry, Madeira, Hock and Moselle are examples of imported white wines.

For pharmaceutical purposes, a wine stronger in alcohol is required, than can be prepared by simple fermentation, the highest thus obtained being 13.75 per cent by weight, or 17 per cent by volume. For this reason from 10 to 15 per cent of Alcohol is added to wine when it is used as a menstruum or solvent in the Medicated Wines. The greater proportion of alcohol prevents acetic fermentation, and thus better preserves the preparations.

*Vinum Rubrum*, U. S., refers to dry Red Wines of domestic production, such as Claret, Zinfandel and Burgundy. Claret and the various kinds of Port are examples of imported red wines.

*Malt Liquors* are made by the fermentation of infusions of malt to which hops have been added; they contain a smaller proportion of alcohol than wines; usually from 5 to 8 per cent.

*Brandy*.—*Spiritus Vini Gallici*, U. S.—An alcoholic liquid obtained by the distillation of the fermented, unmodified juice of fresh grapes, and at least four years old. Its sp. gr. should not be more than 0.941 nor less than 0.925, corresponding to an alcoholic strength of 39 to 47 per cent by weight (46-55% vol.).

Brandy improves with age the same as whisky, the improvement in each

case being chiefly due to the gradual chemical change and disappearance of the traces of fusel oil that could not be separated by fractional distillation.

From the Grape-juice indirectly the following is produced:

*Tartaric Acid.*— $\text{H}_2\text{C}_4\text{H}_4\text{O}_6$ .—Acidum Tartarium, U. S.—A di-basic acid found either free or in combination in the juices of many fruits—as grapes, tamarinds, sumach berries, pineapples, etc. Its principal commercial source is from Cream of Tartar, which in turn is derived from the crude tartar or Argol that collects in the form of crystalline crusts on the sides of casks of fermenting wine.

Cream of Tartar is decomposed by Calcium Carbonate into Calcium Tartrate and the latter is decomposed by Sulphuric Acid setting the Tartaric Acid free, which is then obtained in a pure form by crystallization.

Colorless crystals of oblique rhombic prisms, not deliquescent, containing no water of crystallization, inodorous, intensely but agreeably sour, soluble in 0.8 parts of water and in 2.5 parts of alcohol, and in 250 parts of ether nearly insoluble in chloroform and benzin.

Tartaric acid is not much used medicinally, but in the powdered form is an ingredient in Seidlitz powder.

*Off. Prep.*—Pulv. Effervescent comp.

Closely related to Tartaric Acid is Citric Acid, the two often occurring together in fruits.

*Citric Acid.*— $\text{H}_3\text{C}_6\text{H}_5\text{O}_7 + \text{H}_2\text{O}$ .—Acidum Citricum, U. S.—A tribasic acid, obtained chiefly from the juice of lemons and limes.

The juice is first clarified by boiling, and the clear liquid treated with Calcium Carbonate. From the Calcium Citrate thus formed the Citric Acid is liberated by treating it with Sulphuric Acid, and afterwards repeatedly crystallizing.

Colorless, transparent, right-rhombic prisms, of an agreeably acid taste, soluble in 0.63 parts of water and 0.4 parts of boiling water, in 1.61 parts of alcohol and in 18 parts of ether. If an aqueous solution of it be added to lime-water it remains clear until boiled, when a white precipitate falls, which will nearly all be taken up when the liquid cools. Citric Acid is distinguished from Tartaric Acid, aside from its solubilities, in decomposing without emitting the odor of burning sugar when slowly ignited, and in not producing a precipitate with a solution of Potassium Acetate upon the addition of alcohol.

*Uses.*—In making the Citrates and in the Liquor Magnesii Citratis and Liquor Potassii Citratis.

## Drugs of Group II.

### ACID SACCHARINE DRUGS.

This group, also called "refrigerant drugs," includes those drugs whose virtues chiefly depend on the presence of Sugar and such organic acids as citric, malic and tartaric acids. Many of them possess mildly laxative properties.

*Cassia Fistula*.—Cassia Fistula, U. S.—Fruit of Cassia Fistula, Linne. Constituents: Sugar, mucilage, pectin, fruit acids. Off Prep.: Confectio Sennæ.

*Uses*.—The pulp is prepared by treating the cassia with water, freeing the mixture from the seeds and woody portion by straining and evaporating the liquid; yield, about 30 per cent.

*Lemon Juice*.—Limonis Succus, U. S.—Fresh juice of ripe fruit of Citrus Limonum, Risso. Constituents: Citric acid from 7 to 10 per cent malic acid, sugar and gum. Preparations, U. S. Ph., '80: Mixture Potassii Citratis; Syrupus Limonis.

Lemon juice is liable to become moldy or otherwise unfit for use. It may be prepared by precipitating the gum by the addition to the juice of one-half its weight of alcohol, the clear portion heated to expel the alcohol, and bottled while hot.

*Raspberry*.—Rubus Idæus, U. S.—Fruit of Rubus Idæus, Linne. Constituents: Sugar, citric and malic acids, pectin, glucose, trace of volatile oil, coloring matters. Off. Prep.: Syrupus Rubi Idæi.

*Uses*.—In the preparation of Raspberry Syrup, the crushed berries are allowed to stand for about 36 hours, so as to undergo a slight fermentation. The expressed juice is clarified by standing, filtered and the Sugar dissolved in the filtrate by heat. The Syrup is brought to the boiling point, strained, bottled while hot and kept in a cool place.

*Tamarind*.—Tamarindus, U. S.—Preserved pulp of fruit of Tamarindus Indica, Linne. Constituents: Citrates, malates, tartrates, acetates; also sugar, pectin, tannin. Off. Prep.: Confectio Sennæ.

*Uses*.—The pulp is prepared by treating tamarinds, with water, expressing and straining the expressed liquid, then evaporating to the consistence of a pulp, or a very soft extract.

*Rhus Glabra*.—Rhus glabra, U. S.—Smooth Sumach. Fruit of Rhus glabra, Linne. Constituents: Acid calcium and potassium malates, tannin, coloring matter. Off. Prep.: Extractum Rhois Glabrae Fluidum.

## Essential Oils.

The Essential or *volatile* Oils bear some resemblance in their appearance and physical properties to the *fixed* oils or fats, but they differ from them (1) in chemical composition, (2) in their specific gravities, (3) in their boiling points, (4) in being completely volatizable without decomposition or change and therefore not leaving a stain when volatilized from paper and (5) in not being saponified by alkalies.

They are slightly soluble in water, in certain proportions of alcohol, but freely soluble in ether, and the fixed oils; they are all inflammable, and all burn with a smoky flame. In specific gravity they range from 0.82 to 1.18, but by far the larger portion of them are lighter than water. Their boiling point is higher than that of water—ranging from 150°C. to 250°C. They are supposed to be perfectly transparent and colorless when pure, but all undergo change on standing, being partly converted into resin, and acquire various, often characteristic, colors.

As to their origin, few occur in animal structures, but they are widely distributed in the vegetable kingdom, and their varieties are very numerous. Sometimes they are diffused through the entire structure of the plant, sometimes they are confined to a part, as to the flower, or the fruit; sometimes they occupy separate cells, or conceptacles, as in the rind of the Orange, and the oil tubes in the fruits of the Umbelliferae. They are usually found associated with resins, and hold them in solution. For the plants that produce them they serve various purposes. The turpentine of Pines, and Oil of Mustard and Horseradish are doubtless protective, while those volatile oils that give rise to the pleasant odors of certain flowers serve the purpose of attracting winged insects that aid in cross-fertilization.

### PRESERVATION.

Volatile oils undergo changes by standing. These are due partly to the effects of light and partly, probably, to the oxidizing influence of the air. The changes are greatly retarded if the oils be kept in full, tightly-stoppered bottles and in a dark place, or mixed with about 10 per cent of Alcohol. They should not be kept in shop-bottles. Oils that have become discolored by age may be greatly improved by rectification. This is best accomplished by mixing them with an equal bulk of odorless fat and distilling them from a solution of common salt in water.

## ADULTERATIONS.

Volatile oils are liable to be adulterated with (1) fixed oils, (2) alcohol, and (3) with other (cheaper) volatile oils.

*Fixed oils* may be detected by placing a drop of the suspected oil upon a piece of clean white paper and gently heating it; if they be present, the oil will leave a permanent stain. Also fixed oils, if present in considerable quantity, will be separated on the addition of alcohol.

*Alcohol* may be detected by observing whether or not contraction takes place when measured quantities of the oil and water are mixed in a graduated glass tube. If contraction takes place, alcohol is present, and the amount of contraction indicates approximately the quantity of alcohol present.

Separation of alcohol may also be effected by adding a fixed oil, such as Olive Oil, which dissolves in the volatile oil and throws alcohol, if present, out of solution. *Red anilin* may also be used as a test, as it is soluble in alcohol but entirely insoluble in the volatile oils. If, therefore, the sample tested is colored *red*, it indicates the presence of alcohol as an impurity.

*Admixture* of other cheaper volatile oils is more difficult of detection.

It is usually the case that if a drop of mixed oils be evaporated, either from the hand or from a sheet of paper warmed over a lamp, the difference may be detected by observing the odor from time to time, as one of the essential oils is likely to volatilize more rapidly than the other.

If the oxygenated oils are adulterated with Turpentine, as is likely to be the case on account of its cheapness, its presence may often be detected by treating a portion of the suspected oil with 85 per cent alcohol, in which the turpentine is less soluble than the oxygenated essences, and will therefore separate out.

In judging of essential oils by the sense of smell, particularly if they are alcoholic solutions, it is always better to rub a drop on the hand and then smell of it, than to smell of it directly from the bottle, as in the latter case the pungent odor of the alcohol, if present, obscures the odor of the essence, and evaporation of the oil can not take place so rapidly from the liquid surface in the bottle as from the warm hand.

The volatile oils, or "Ethereal oils" as they are more correctly termed, enter largely into medicinal preparations, sometimes for the sake of flavor, as in the official spirits or "essences" sometimes as aromatic stimulants, as in the Medicated Waters or in the Elæosacchara of the Nat. Form.; but more frequently as correctives of nauseous drugs.

## METHODS OF PREPARATION.

The volatile oils are extracted in various ways:

(1) By Expression, as in the case with the oils of Orange, Lemon and Bergamot, where the oil is secreted in conceptacles in the rinds of the fruit.

(2) By Distillation from Oleoresins. The oleoresins are resins in solution in volatile oils, such as Turpentine and Copaiba from which respectively volatile oils are obtained.

## (3) By Distillation of the aromatic substance with water.

The Substance coarsely comminuted, or in the fresh state as for example Peppermint, is first macerated with water in a still. Upon applying heat the water boils and vaporizing carries the oil with it. The oil being less soluble in the distillate separates and usually of a lower specific gravity than water, floats on top of the water from which it is collected. This separation is usually effected by using a Florence flask as a receiver. The distillate is a saturated solution of the oil in water and may be used instead of water in subsequent similar operations or as an aromatic water; Rose Water and Orange Flower Water are obtained in this way as by-products in the distillation of their respective oils. Most volatile oils, although their boiling points are higher than that of water, owing to their volatility, distill readily in this way, but in case the boiling point of the oil be very high, common salt is sometimes added to the water, to raise its boiling point, or the process is hastened by passing a current of steam into the bottom of the still.

(4) By extraction with *volatile* solvents, such as Alcohol, Ether, Chloroform, Benzin, Carbon Disulphide, etc.

The solvent is permitted to evaporate, leaving the volatile oil mingled with some impurities, from which it is freed by distillation.

(5) By extraction with *fixed* solvents, such as Fixed Oils and Fats.

The process of distillation, though more speedy and convenient, is too wasteful where it is desired to collect the delicate volatile essences of flowers, which frequently are present in the flowers only in minute proportions: so, for this purpose, the process of *ensfleurage* is usually adopted.

*Ensflleurage* consists in sprinkling the material, from which the essence is to be extracted, on the surface of some purified and odorless fat contained in shallow trays. The fat after a time takes up the essence, and the exhausted material may be replaced by fresh and the process continued until a strongly perfumed *pomade* is obtained. If this pomade be now treated with Alcohol the essence is dissolved, while but little of the fat passes into solution, and that little may be separated by exposing the alcoholic solution to a low temperature, when the fat crystallizes out. The product thus obtained is the "extract" of the perfumers. The volatile oil may be obtained from this by treating it with water, when the oil separates out.

The volatile oils are classified according to their elementary composition as follows:

1. The *Terpenes* or Camphenes, also called "Hydrocarbons" because they have the Composition  $C_{10}H_{16}$ .
2. The *Oxygenated Oils* or "Essences," which contain Oxygen in addition to Carbon and Hydrogen.
3. The *Nitrogenated*, containing Nitrogen in addition to Carbon, Hydrogen and Oxygen, and
4. The *Sulphurated*, consisting of Carbon, Hydrogen, Nitrogen and Sulphur.

#### THE TERPENES.

The Terpenes, so-called because Oil of Turpentine is the type, include the volatile oils derived from plants belonging mostly to the natural order Coniferæ.

They are characterized by ranging in specific gravity from 0.840 to 0.890; in boiling point from 150°C. to 250°C.; in being less soluble in water than oils of the other groups and being converted into para-Cymol,  $C_{10}H_{14}$ , through withdrawal of two H by reaction with Iodine, which becomes so intense as to cause *fulmination*. They also react strongly with Nitric and Sulphuric Acids and these must be cautiously added when desired to be mixed with these oils.

*Oil Turpentine*.—*Oleum Terebinthinæ*, U. S.—Obtained by distillation of Turpentine, an Oleoresin derived from *Pinus palustris* and other species of the Pine. The residue is the common resin or colophony.

A colorless liquid of a characteristic odor and taste, sp. gr. 0.855 to 0.870, boils at 155 to 170°C., soluble in 3 volumes of alcohol and in an equal volume of glacial acetic acid.

*Uses*.—As a solvent for resins, etc., externally in Liniments; internally dissolved in a fixed oil or in the form of emulsion, the purified form being employed.

*Off. Prep.*.—Linimentum Terebinthinæ and the following:

*Oleum Terebinthina Rectificatum*, U. S.—Prepared by shaking common Oil of Turpentine with six volumes of Lime Water, distilling the mixture and collecting about three-fourths of the oil employed and separating it from water.

This purified oil added to boiling water is used as an inhalant in "consumption," bronchitis, etc. The Emulsion is best made by dissolving 5 C.C. of the Oil in 10 C.C. of Almond Oil, emulsifying with 5 Gm. powdered Acacia and water to make 100 C.C.

Oil of Turpentine is a mixture of several substances called pinene, terpinene and dipentene, which differ chiefly in their optical behavior, i. e., turning polarized light to the left, *levogyrate*, or to the right, *dext-*

*trogyrate.* Treated with Sulphuric Acid, added in small portions at a temperature not above 70°C., washed with alkali water and that portion boiling under 160°C. separated by fractional distillation, the following is obtained:

*Terebene.*— $C_{10}H_{16}$ .—Terebenum, U. S.—A liquid consisting chiefly of Pinene, optically inactive, sp. gr. 0.862.

It is sparingly soluble in water, but soluble in an equal volume of alcohol, glacial acetic acid or carbon disulphide.

*Uses.*—As an antiseptic and deodorant.

*Terpin Hydrate.*— $C_{10}H_{18}(OH)_2 + H_2O$ .—Terpini Hydras, U. S.—The hydrate of the diatomic alcohol Terpin.

Produced through the action of Nitric Acid on Oil of Turpentine in the presence of Alcohol and crystallizing from hot alcohol or glacial acetic acid.

Colorless, lustrous, rhombic prisms, nearly odorless and having a slightly aromatic taste, soluble in 250 parts of water, in 10 of alcohol, in 100 of ether, in 200 of chloroform and in 1 part of boiling glacial acetic acid.

*Uses.*—In Bronchial difficulties, dose 1 deg.

The following Oils are also included with the Terpenes:

Oleum:	part of.	plant.	sp gr. 1 <sup>#</sup> .	1 vol sol in alcohol	volts.
Juniperi . .	fruit . .	J. communis . .	0.85 . . . . .	4.	
Sabinæ . .	tops . .	J. Sabina . .	0.91 . . . . .		
Rosmarini . .	leaves . .	R. officinalis . .	0.895 . . . . .	1.	
Lavandulae . .	flor. . .	L. officinalis . .	0.885 . . . . .		
Erigerontis . .	hb. . .	E. Canadense . .	0.850 . . . . .	1.	
Myrciae . .	leaves . .	M. acris . . . . .	0.975 . . . . .	1.	
Myristicæ . .	seed . .	M. fragrans . . . . .	0.870 . . . . .	1.	
Eucalypti . .	leaves . .	E. globulus . . . . .	0.915 . . . . .		
Cubebæ . .	fruit . .	Piper Cubeba . .	0.920 . . . . .	1.	

*Eucalyptol.*— $C_{10}H_{18}O$ .—A neutral body obtained from the Volatile Oil of Eucalyptus.

Sp. gr. 0.930, boils at 176°C., congeals at a few degrees below the freezing point and is optically inactive.

*Oil of Copiba.*—Oleum Copiba, U. S.—Obtained by distillation from the Oleoresin of Copiba Langsdorffii, Kuntze, and other species.

Sp. gr. 0.800, forming a slightly cloudy mixture with 10 volumes of alcohol.

The Oils of the Citrus Family, now classed with the Terpenes, are all obtained by expression from the rinds of the fruits of their respective plants, except the Oil of Orange Flowers, which is obtained by distillation with water.

\* The sp. gr. ranges usually 10 to 20 in 100, only the lowest is given here.

† Where no figure is given the oil is soluble in alcohol in any proportion.

*Oil of Lemon.*—*Oleum Limonis*, U. S.—*Citrus Limonum*.

Sp. gr. 0.900 to 0.920; soluble in equal volume of alcohol.

*Off. Prep.*—Spirit. *Aurantii Comp.*, Spirit. *Limonis*.

*Oil of Bergamot.*—*Oleum Bergamottæ*, U. S.—*Citrus Bergamia*, Risso et P.

Sp. gr. 0.880 to 0.885, 2 volumes of oil and 1 volume alcohol, clear solution.

*Uses.*—In cologne water, perfumery.

*Oil of Orange.*—*Oleum Aurantii*, U. S.—From either the bitter Orange, *Citrus vulgaris*, Risso, or the sweet Orange, *Citrus Aurantium*, Linne.

Sp. gr. 0.850; soluble in 4 volumes of alcohol.

*Off. Prep.*—Spirit. *Aurantii*; Sp. *Aurant. Comp.*, Sp. *Myrciae*.

*Oil of Orange Flowers.*—*Oleum Aurantii Florum*, U. S.—Oil *Neroli*.—*Citrus vulgaris*, Risso.

Sp. gr. 0.875 to 0.890; soluble in equal volume of alcohol.

#### THE OXYGENATED OILS.

The Oxygenated Oils, or “Essences” as they are sometimes called, comprise a large number of volatile oils, containing, in addition to H and C, also a small proportion of Oxygen.

They are in most cases mixtures of a liquid terpene called *eleoptene* and a solid neutral body called *stearoptene*, which may be separated by fractional distillation, or by congelation (freezing).

Examples of these are the Oils of Mint and Thyme from which the two stearoptenes, *menthol* and *thymol*, are respectively derived. In Oils of Anise and Rose, the stearoptenes, present in large proportion, crystallize at 10° to 15° C., and these oils are therefore semi-liquid at ordinary temperature and require to be liquefied by gentle heat previous to use.

A few of them consist of compound ethers, *esters*, from which acids may be obtained in a crystalline form, as the *salicylic acid* from the Oil of Gaultheria and the Oil of Betula, both identical with Methyl Salicylate, and *cinnamic acid* from Oil of Cinnamon.

Physically they differ from the Terpenes proper, the Turpentines, in having a finer, more agreeable *odor*, hence their value as perfumes; they are more *soluble* in water, and the official Aromatic Waters are saturated solutions of these oils; they have a *higher* specific gravity, ranging with two exceptions from 0.900 to 1.175; and a somewhat higher boiling point.

*Uses.*—A great many oils belonging to this class, not official, are used in perfumery, such as the Ilang, Jasmin, etc.; many are employed as flavors, and the savory herbs of Marjoram, Mints and Thyme, the fruits of Anise, Caraway, Pepper and Coriander, the flowers of Cloves and Mace and the barks of Cinnamon are all used in the culinary arts.

In medicine the oils are employed for their aromatic and stimulant effect, in Waters and Spirits, often as carminatives, and most frequently as adjuvants to nauseous preparations and as correctives to drastic cathartics, as in many of the official pills.

Some have specific effects, as the abortifacients, Pennyroyal, Rue, Tansy (and Sabin) and which, therefore, can be dispensed only on physicians' prescriptions.

Oleum:	part of.	plant.	sp. gr.	1 vol. sol. in alc. vols.
Anisi . . . . fruit . .	Pimpinella A . . . .	A . . . .	0.98 . . . .	1.
Betulæ vol. . . bark . .	B. lenta . . . .	B. lenta . . . .	1.175 . . . .	
Cajuputi . . . leaves . .	Melaleuca Leuca-			
	dendron . . . .	dendron . . . .	0.922 . . . .	1.
Cari . . . . fruit . .	Carum Carui . . . .	Carum Carui . . . .	0.910 . . . .	1.
Caryophylli . . flor's . .	Eugenia arom. . . .	Eugenia arom. . . .	1.060 . . . .	1.
Chenopodii . . fruit . .	C. ambrosioides . . . .	C. ambrosioides . . . .	0.970 . . . .	
Cinnamomi . . bark . .	C. cassia . . . .	C. cassia . . . .	1.055 . . . .	1.
Coriandri . . fruit . .	C. sativum . . . .	C. sativum . . . .	0.870 . . . .	
Fœniculi . . fruit . .	F. capillaceum . . . .	F. capillaceum . . . .	0.960 . . . .	1.
Gaultheriæ . . leaves . .	G. procumbens . . . .	G. procumbens . . . .	1.175 . . . .	
Hedeomæ . . " . .	H. pulegioides . . . .	H. pulegioides . . . .	0.930 . . . .	2.
Menthæ pip. . . "	M. piperita . . . .	M. piperita . . . .	0.900 . . . .	1.
Menthæ vir. . . "	M. viridis . . . .	M. viridis . . . .	0.930 . . . .	1.
Pimentæ . . fruit . .	P. officinalis . . . .	P. officinalis . . . .	1.045 . . . .	1.
Rosæ . . . . flor's . .	R. Damascena . . . .	R. Damascena . . . .	0.865 . . . .	sp.
Santali . . . . wood . .	S. album . . . .	S. album . . . .	0.970 . . . .	
Sassafras . . . rt-bark . .	S. variifolium . . . .	S. variifolium . . . .	1.070 . . . .	
Thymi . . . . leaves . .	T. vulgaris . . . .	T. vulgaris . . . .	0.900 . . . .	0.5

#### THE NITROGENATED OILS.

The nitrogenated or complex oils are but few in number, and the plants which yield them all belong to the Rosaceæ, and most of them to the sub-order Amygdalæ. They contain Hydrocyanic Acid in solution in the oil, and are therefore poisonous.

Their specific gravity varies from 1.04 to 1.07, boiling points from 170°C. to 180°C., and they are acid to litmus paper.

The most important of this group are: Oil of Cherry-seeds, Oil of Cherry-laurel leaves, and:

*Oil of Bitter Almonds.*—Oleum Amygdalæ Amaræ, U. S.—Obtained from Bitter Almonds by crushing them, macerating with water, and afterward distilling.

Its sp. gr. is 1.060, soluble in 300 parts water, in all proportions of alcohol.

It usually contains 50 per cent of Hydrocyanic Acid, and is therefore poisonous.

*Off. Prep.*—Aqua Amygd. Am.; Sp. Amygd. Am.

#### THE SULPHURATED OILS.

The sulphurated oils constitute a series of pungent essences characterized chemically by containing a small proportion of Sulphur. Most of these oils are obtained from plants belonging to the natural order Cruciferæ, but Oil of Asafoetida is derived from an Umbelliferous, and Oil of Garlic from a Liliaceous plant.

*Volatile Oil of Mustard*.—*Oleum Sinapis Volatile*, U. S.—Is obtained from Black Mustard by maceration with water, and subsequent distillation. It occurs, however, in other Cruciferous plants.

A colorless, pungent and acrid liquid; sp. gr. from 1.018 to 1.029, boils at 150°C. Its chemical formula is  $(C_3H_5)(CNS)$ . It is therefore a *sulpho-cyanide* of allyl.

*Oil of Horse-radish* has the same composition.

*Oil of Asafoetida* has the formula  $C_{12}H_{22}S$ , or  $C_{12}H_{22}S_2$ , and *Oil of Garlic*  $C_6H_{10}S$  mixed with  $C_6H_{10}O$

#### CAMPHORS.

Closely allied to the volatile oils are the camphors, and some of the volatile oils may by long exposure to water and the atmosphere be converted into camphors.

Common camphor is derived from the wood, branches and roots of *Cinnamomum Camphora*, a tree which belongs to the Laurineæ, and grows in Eastern and Southeastern Asia. The camphor is obtained by distillation of the chips with water, and the product is afterward purified by sublimation.

*Camphor*.— $C_{10}H_{16}O$ .—*Camphora*, U. S.—A stearopten melting at 175°C., boils at 204°C.; sp. gr. 0.995. It is volatile at ordinary temperature and burns with a sooty flame.

Sparingly soluble in water, readily in alcohol, ether, chloroform, fixed and volatile oils.

Triturated in molecular proportions with menthol, thymol, phenol, or chloral hydrate, liquefaction ensues.

Owing to the toughness of its crystals, it cannot be pulverized in a mortar unless first moistened with alcohol, ether, or volatile oil. It may, however, be obtained in a finely divided state by condensing the hot vapors.

*Off. Prep.*—Aqua Camphoræ; Ceratum Camphoræ; Ceratum Plumbi Subacetatis; Linimentum Belladonnæ; Linimentum Saponis; Linimentum Sinapis Comp.; Spiritus Camphoræ, Tinctura Opii Camphoratae.

*Borneo Camphor* is of different composition, and has the formula  $C_{10}H_{18}O$ . It is derived from fissures in the wood of *Dryobalanops Camphora*, a tree belonging to the Dipterocarpaceae. It grows in the islands of Borneo and Sumatra.

This camphor is slightly heavier than water, is less volatile; and by the action of nitric acid is converted into ordinary camphor.

*Camphora monobromata*,  $C_{10}H_{15}BrO$ , a combination of camphor and bromine. It has similar uses in medicine to those of the bromine compounds.

With the Camphors may be classed the following substances:

*Thymol*.—Thymol, U. S.—A substance, chemically a phenol, obtained from the volatile oils of *Thymus vulgaris*, and *Monarda punctata*, L., and *Carum Ajowan*, B. and H.

By fractional distillation the terpenes are separated and the portion coming over at 175°C. is treated with soda, decomposed by hydrochloric acid and the thymol crystallized from an alcoholic solution.

Large, colorless crystals, sp. gr. 1.069, melts at 50°, sparingly soluble in water (1200), readily in alcohol, ether, etc., fixed and volatile oils.

*Uses*.—As an antiseptic and disinfectant.

*Menthol*.— $C_{10}H_{19}OH$ .—Menthol, U. S.—A stearopten obtained by fractional distillation from American and Japanese peppermint oils.

Colorless, acicular or prismatic crystals, melting at 43 C., boil at 212 C., sparingly soluble in water, freely in alcohol, ether, etc.

*Uses*.—It has been used extensively as a topical application in nervous headache.

## Aromatic Drugs, Group III.

The Aromatic Drugs include those vegetable drugs whose chief value consists in the volatile oil which they contain. They are mostly stimulant and carminative in their properties.

A few of them, Buchu, Cubeb, Eucalyptus, Ginger and Valerian, are sufficiently active to be administered alone in simple preparations, but the rest are merely used as aromatics and adjuvants, and enter largely into various compounds. Their preparations, with one or two exceptions, precipitate with water, and in the degree this precipitation takes place, the strength of the preparation, or the quality of the drug from which it is prepared, may be roughly estimated.

Nearly all require stronger alcoholic menstrua in their extraction, yet the solvent should contain some water which, by causing the cell-walls to swell, enables the alcohol to dissolve the active constituents and facilitate the extraction of the drug.

The active principles or volatile oils of some of the drugs belonging to this class, especially those of the Orange and Rose families, are soluble *to some extent* in Syrup, which is the most common form of exhibition; they are, however, still less soluble in water not containing sugar, and such solutions can not, therefore, be so concentrated that the syrups can be prepared from them by admixture with simple syrup. Their principal use is in the manufacture of essential oils.

Drugs may contain a volatile oil and yet contain other constituents, such as resins, tannin or glucosides and alkaloids. In such cases reference is made to the Drug in this Group, but it is described in the particular Group in which, through its most active constituents, it would be most appropriately included.

*Absinthium*.—[See Group 4.]

*Anise*.—Anisum, U. S.—Fruit of Pimpinella Anisum, Linne. Nat. Ord., Umbelliferae. Constituents: Vol. oil about two per cent. sugar, mucilage, etc. Off. Prep.: Tinctura Rhei Dulcis.

*Arnica*.—Flowers and Root. [See Group 4.]

*Buchu*.—Buchu, U. S.—Leaves of Barosma betulina, Bart., B. crenulata, Hook. Nat. Ord., Rutaceæ. Constituents: Vol. oil about one per cent. resin, bitter principle, etc. Off. Prep.: Extractum Buchu Fluidum; Tinctura Buchu was formerly official.

*Short buchu* is the only kind recognized in the U. S. Ph. It contains a larger percentage of oil than the variety known as "long" buchu (*Barosma serratifolia*) and is much lower in price.

*Calamus*.—*Calamus*, U. S.—Rhizome of *Acorus Calamus*, Linne. Nat. Ord., Aroideæ. Constituents: Vol. oil one-half per cent, bitter principle, resin, etc. Off. Prep.: Extractum Calami Fluidum.

*Uses*.—A tincture containing 20 per cent of the drug made with the alcohol, sp. gr. 0.892 and an extract with 60 per cent alcohol, are prepared according to the Ph. Ger. Infusion is made 5 per cent strength. A conserve is also made from the peeled root with sugar.

*Caraway*.—*Carum*, U. S.—Fruit of *Carum Carui*, Linne. Nat. Ord., Umbelliferæ. Constituents: Vol. oil six per cent. Off. Prep.: Tinctura Cardamomi Comp.

*Uses*.—As an aromatic in different Elixirs and "Tonics," also as condiment, and as an ingredient in cheese.

*Cardamom*.—*Cardamomum*, U. S.—Fruit of *Elettaria repens*, Baillon. Nat. Ord., Scitamineæ. Constituents: Vol. oil four-fifths per cent, fixed oil, mucilage, etc. Off. Prep.: Puvis Aromaticus; Tinctura Cardamomi; Tinctura Cardamomi composita; Tinctura Gentianæ comp.; Tinctura Rhei; Tinctura Rhei Dulcis; Extract. Colocynthidis Comp.

*Malabar* and *Aleppo* constitute the shorter varieties of Cardamom, which are round in shape, while the *Madras* are more elongated. Good Cardamom should yield 75 per cent of their weight in seeds.

*Cascarilla*.—*Cascarilla*, U. S.—Bark of *Croton Eluteria*, Bennett. Nat. Ord., Euphorbiaceæ. Constituents: Vol. oil one-fifth per cent, cascarillin, and resin.

*Uses*.—Chiefly as an ingredient in "fumigating mixtures." When incinerated, it gives off an odor resembling that of musk.

Extractum Cascarillæ Ph. Ger. is prepared by exhausting the bark with hot water and evaporating the liquid.

*Chenopodium*.—*Chenopodium*, U. S.—American Wormseed. Fruit of *Chenopodium ambrosioides*, var. *anthelminticum*, Gray. Nat. Ord., Chenopodiaceæ. Constituents: Volatile oil.

*Uses*.—In the form of infusion and for the preparation of the volatile oil.

*Cassia Cinnamon*.—*Cinnamomum Cassia*, U. S.—Cassia Bark.—The bark of the shoots of one or more undetermined species of *Cinnamomum* grown in China (Chinese Cinnamon). Nat. Ord., Laurineæ.

*Saigon Cinnamon*.—*Cinnamomum Saigonicum*, U. S.—The bark of an undetermined species of *Cinnamomum*.

*Ceylon Cinnamon*.—*Cinnamomum Zeylanicum*, U. S.—The inner bark of the shoots of *Cinnamomum Zeylanicum*, Breyne.

Constituents.—About 1 per cent of volatile oil, and a little tanin.

*Uses*.—Cinnamon is valuable in medicine chiefly for its carminative and stimulant virtues and for the preparation of the volatile oil.

*Off. Prep.*—Pulvis Aromaticus; Infusum Digitalis; Tinctura Cinnamomi; Tinct. Cardamomi comp.; Tinct. Catechu comp.; Tinct. Lavandulae comp.; Tinc. Rhei Aromat.; Vinum Opii; also in numerous unofficial preparations and in Elixirs.

*Uses.*—In the powdered form as a spice and sometimes for dusting pills. Cassia Cinnamon is the kind mostly used for culinary purposes; Saigon for flavoring cordials, elixirs, etc.; Ceylon Cinnamon in perfumery, also for flavoring, as in preparing Aqua Cinnamomi Ph. Br.

*Cloves.*—*Caryophyllus*, U. S.—Unexpanded flowers of *Eugenia aromatica*, Kuntze. Nat. Ord., Myrtaceæ. Constituents: Volatile oil eighteen per cent, caryophyllin, eugenin, resin, tannin, etc. Off. Prep.: Tinctura Lavandulæ comp.; Tinct. Rhei Arom.; Vinum Opii, and externally as an ingredient in the unofficial Spice Plaster.

*Coriander.*—*Coriandrum*, U. S.—Fruit of *Coriandrum sativum*, Linne. Nat. Ord., Umbelliferæ. Constituents: Volatile oil one-half per cent and fixed oil.

*Uses.*—To correct griping in laxative remedies as in the official Confection of Senna; as a very agreeable flavor in Elixirs, and as a promoter of digestion in the compound of various spices, known as "Curry Powder."

*Cubeb.*—*Cubeba*, U. S.—Unripe fruit of *Piper Cubeba*, Linne fil. Nat. Ord., Piperaceæ. Constituents: Volatile oil ten per cent, resin, cubebin, cubebic acid. Off. Prep.: Extractum Cubebæ Fluidum; Oleoresina Cubebæ, Tinctura Cubebæ.

Cubebic acid and cubebin, also described as indifferent resin, represent all the medicinal value of cubeb, the oil being regarded as nearly inert.

*Uses.*—Crushed and made into cigarettes for smoking, powdered and mixed with potassium sulphate as Catarrh Snuff, and made into a paste with mucilage and Copiba for gonorrhœa.

*Eriodictyon.*—*Eriodictyon*, U. S.—*Yerba Santa*.—The leaves of *Eriodictyon glutinosum*, Bentham. Nat. Ord., Hydrophyllaceæ. Constituents: Volatile oil, an acid and possibly a glucoside. Off. Prep.: Extractum Eriodictyi Fluidum.

*Eucalyptus.*—*Eucalyptus*, U. S.—Leaves of *Eucalyptus globulus*, Labillardiere. Nat. Ord., Myrtaceæ. Constituents: Volatile oil six per cent, resin, tannin. Off. Prep.: Extractum Eucalypti Fluidum.

*Uses.*—As an addition to quinine mixtures, and externally as a wash in Gangrene, etc.; also in conjunction with cubeb for smoking in Catarrh.

*Fennel.*—*Foeniculum*, U. S.—Fruit of *Foeniculum capillaceum*, Gilibert. Nat. Ord., Umbelliferae. Constituents: Volatile oil about four per cent, fixed oil, sugar. Off. Prep.: Infusum Sennæ comp.

*Uses.*—In Species Laxantes Ph. Ger., "St. Germain" or "Hamburger The" and similar preparations to correct the harsh action of purgatives; also largely as infusion for children.

*Ginger*.—Zingiber, U. S.—Rhizome of *Zingiber officinale*, Roscoe. Nat. Ord., Scitamineæ. Constituents: Volatile oil one-half per cent, gingerol, resin, starch, etc. Off. Prep.: Extractum Zingiberis Fluidum; Oleoresina Zingiberis; Pulvis Aromaticus; Pulvis Rhei comp.: Tinctura Zingiberis.

Ginger occurs in the market usually with the outer integuments removed, when it is called "uncoated ginger;" it is also frequently bleached by immersion in a solution of chlorinated lime to give it a white appearance. Of the two varieties, the African and the Jamaica, only the latter (unbleached) should be used in pharmacy.

*Uses*.—Similar to the other spices, and as an ingredient in "Curry Powder."

*Hedeoma*.—Hedeoma, U. S. — Pennyroyal.—Leaves and flowering tops of *Hedeoma pulegioides*, Persoon. Nat. Ord., Labiateæ. Constituents: Volatile oil.

*Uses*.—As infusion to bring on retarded or suspended menstruation.

*Illicium*.—Illicium, U. S.—Star-anise.—Fruit of *Illicium verum*, Hooker, fil. Nat. Ord., Magnoliaceæ. Constituents: Volatile oil about four per cent, fixed oil about fifteen per cent, and resin and some tannin.

*Uses*.—As a substitute for *pimpinella anise* and as a source of oil of anise. It possesses a delicious flavor.

*Lemon Peel*.—Limonis Cortex, U. S. — Rind of fruit of *Citrus Limonum*, Risso. Nat. Ord., Rutaceæ. Constituents: Volatile oil two per cent, hesperidin. Off. Prep.: Spiritus Limonis.

*Uses*.—For flavoring, and in the Spirit of Lemon for imparting a lemon-yellow color to the alcoholic solution of the oil.

*Mace*.—Macis, U. S.—The arilode of nutmeg, the seed of *Myristica fragrans*, Houttuyn. Nat. Ord., Myristicaceæ. Constituents: Volatile oil about eight per cent, fixed oil, resin.

*Uses*.—Tincture of Mace, Ph. Ger., is prepared by digesting one part of mace in five parts of alcohol. Mace is mostly used as a condiment, and as it cannot be powdered without addition of other substances, should be used whole.

*Marrubium*.—Marrubium, U. S.—Horehound.—Leaves and tops of *Marrubium vulgare*, Linne. Nat. Ord., Labiateæ. Constituents: Volatile oil, resin, marrubin, tannin.

*Uses*.—Popularly as an ingredient in Cough Syrups and as Infusion.

*Matico*.—[See Group 4.]

*Melissa*.—Melissa, U. S.—Balm.—Leaves and tops of *Melissa officinalis*, Linne. Nat. Ord., Labiateæ. Constituents: Volatile oil one-sixth per cent, tannin, bitter extractive.

*Uses*.—For preparing *Aqua Melissa* Ph. Ger. by distillation with water also in a French preparation, "Eau de Carmes," or Compound Spirit of Balm.

*Nutmeg.*—*Myristica*, U. S.—The seed of *Myristica fragrans*, Houttuyn. Nat. Ord., *Myristicaceæ*. Constituents: Volatile oil about five per cent, and fixed oil twenty-five to thirty per cent. Off. Prep.: *Pulvis Aromaticus*; *Acetum Opii*; *Tinctura Lavandulæ composita*; *Tinct. Rhei Arom.*: and as a flavor in several official Troches.

*Bitter Orange Peel.*—*Aurantii Amari Cortex*, U. S.—Rind of fruit of *Citrus vulgaris*, Risso. Nat. Ord., *Rutaceæ*. Constituents: Volatile oil and hesperidin. Off. Prep.: *Extractum Aurantii Amari Fluidum*; *Tinctura Aurantii Amari*; *Tinct. Cinchonæ comp.*; *Tinct. Gentianæ comp.*.

*Uses.*—Owing to its large percentage of bitter principle, Bitter Orange Peel is used in the several official tinctures, and also in many unofficial tonics and bitters. The volatile oil, while present in much smaller quantity than in the Sweet Orange Peel, is largely used, and sometimes preferred to that of the latter. The volatile oil obtained from the unripe fruit of bitter orange (orange berries) called *essence de petit grain*, is similar in chemical composition, but differs in the physical characteristics of taste and odor.

*Sweet Orange Peel.*—*Aurantii Dulcis Cortex*, U. S.—Rind of fruit of *Citrus Aurantium*, Risso. Nat. Ord., *Rutaceæ*. Constituents: Volatile oil and hesperidin. Off. Prep.: *Syrupus Aurantii Coit.*; *Tinctura Aurantii Dulcis*.

*Uses.*—The fresh rind, when obtainable, should always be given the preference over the dried, when used for flavoring purposes. A tincture is made by macerating the yellow exterior portion, deprived of the inner white fleshy portion, with alcohol, and expressing. It is the chief flavor for Elixirs.

*Pepper.*—*Piper*, U. S.—Black Pepper.—Unripe fruit of *Piper nigrum*, Linne. Nat. Ord., *Piperaceæ*. Constituents: Volatile oil one-half per cent, piperin, pungent resin. Off. Prep.: *Oleoresina Piperis*.

*Uses.*—Sometimes as an addition to Anti-Chill Pills to render other remedies, such as quinine, more active. It is the best known and most largely used of all condiments. The powder is often largely adulterated.

*Peppermint.*—*Mentha Piperita*, U. S.—Leaves and tops of *Mentha piperita*, Linne. Nat. Ord., *Labiatae*. Constituents: Volatile oil one per cent, pipmenthol, resin, tannin. Off. Prep.: *Spiritus Menthae Piperitæ*.

*Uses.*—Almost exclusively for obtaining oil of Peppermint; also for imparting a green color to the alcoholic solution of the oil in Essence of Peppermint, and as Infusion.

*Pimenta.*—*Pimenta*, U. S.—Allspice.—Nearly ripe fruit of *Pimenta officinalis*, Lindley. Nat. Ord., *Myrtaceæ*. Constituents: Volatile oil three-fourths per cent, resin, tannin, etc.

*Uses.*—Exclusively as a condiment and for obtaining the oil, which is used in the preparation of "Bay Rum."

*Pale Rose*.—*Rosa Centifolia*, U. S.—Petals of *Rosa centifolia*, Linne. Nat. Ord., Rosaceæ. Constituents: Volatile oil, sugar, mucilage, tannin. Off. Prep.: Syrupus Sarsaparillæ compositus.

*Uses*.—In perfumery; in the distillation of Rose Water and in Fumigating Powder.

*Red Rose*.—*Rosa Gallica*, U. S.—Petals of *Rosa Gallica*, Linne. Nat. Ord., Rosaceæ. Collected before flowers are fully expanded. Constituents: Volatile oil, sugar, mucilage, quercitrin. Off. Prep.: Pilulæ Aloes et Mastiches; Confectio Rosæ.; Extractum Rosæ Fluidum; Mel Rosæ.

*Uses*.—The Infusion, formerly official, containing sugar and dilute sulphuric acid, as a vehicle for bitter drugs, *i. e.*, magnesium sulphate and quinine; also as a gargle for sore throat.

*Saffron*.—*Crocus*, U. S.—Stigmas of *Crocus sativus*, Linne. Nat. Ord., Iridæ. Constituents: Volatile oil, crocin. Off. Prep.: Tinctura Croci; also Syrupus Croci, French Codex.

*Uses*.—Chiefly as a dye and as infusion to produce diaphoresis in "measles." It enters also largely into preparations of the older Pharmacopœias. Saffron is largely adulterated; the so-called American Saffron is from an entirely different plant (*Carthamus*), and should not be dispensed as a substitute for *Crocus*.

*Salvia*.—*Salvia*, U. S.—Sage.—Leaves of *Salvia officinalis*, Linne. Nat. Ord., Labiate. Constituents: Volatile oil one-half to three-quarters per cent, resin, tannin, extractive matter.

*Uses*.—Infusion in sore mouth and as a gargle in sore throat.

*Sambucus*.—*Sambucus*, U. S.—Elder.—Flowers of *Sambucus Canadensis*, Linne. Nat. Ord., Caprifoliaceæ. Constituents: Volatile oil, resin, mucilage, etc.

*Uses*.—In compound Syrup of Stillingia; in Species Laxantes Ph. Ger. and as Infusion.

*Sassafras*.—*Sassafras*, U. S.—Root bark of *Sassafras variifolium*, Kuntze. Nat. Ord., Laurineæ. Constituents: Volatile oil four per cent, tannin six per cent, sassafrid nine per cent. Off. Prep.: Decoc-tum Sarsaparillæ comp.; Extractum Sarsaparillæ comp. fluidum.

*Uses*.—Chiefly in the preparation of the oil of sassafras by distillation; in infusion as "tea" for purifying the blood, and in Species Lignorum Ph. Ger.

*Scutellaria*.—*Scutellaria*, U. S.—Skullcap.—Plant of *Scutellaria lateriflora*, Linne. Nat. Ord., Labiatæ. Constituents: Volatile oil, bitter principle, tannin. Off. Prep.: Extractum Scutellariæ Fluidum.

*Spearmint*.—*Mentha viridis*, U. S.—Leaves and tops of *Mentha viridis*, Linne. Nat. Ord., Labiatæ. Constituents: Volatile oil about one-half per cent, resin, etc. Off. Prep.: Spiritus Menthæ Viridis.

*Sumbul.*—Sumbul, U. S.—Root of *Ferula Sumbul*, Hooker filius. Nat. Ord., Umbelliferæ. Constituents: Volatile oil one-third per cent, angelic and valerianic acids and bitter extractive. Off. Prep.: Tinctura Sumbul.

*Tansy.*—*Tanacetum*, U. S.—Leaves and tops of *Tanacetum vulgare*, Linne. Nat. Ord., Compositæ. Constituents: Volatile oil one-fourth per cent, bitter principle, resin, tannin.

*Uses.*—Infusion to bring on suspended menstruation, and in the preparation of the oil.

*Thuja.*—[See Group 4.]

*Valerian.*—*Valeriana*, U. S.—Rhizome and rootlets of *Valeriana officinalis*, Linne. Nat. Ord., Valerianeæ. Constituents: Volatile oil one-half to two per cent, valerianic, formic and acetic acids, and resin. Off. Prep.: Extractum Valerianæ Fluidum; Tinctura Valerianæ; Tinctura Valerianæ Ammoniata.

Two kinds of Valerian are found in the market, viz.: English and German, the former being regarded as representing the medicinally valuable constituents in a higher degree than the German. It should always be given the preference, but never used until freed from adhering dirt by washing with water.

*Uses.*—Infusion and the powder in the form of pills.

Extract of Valerian was discarded in the U. S. Ph., '80, the Abstract taking its place; the abstract represents the drug quite as fully as the extract, and may be dispensed in the same dose.

*Vanilla.*—*Vanilla*, U. S.—Fruit of *Vanilla planifolia*, Andrews. Nat. Ord., Orchideæ. Constituents: Vanillin, fixed oil, resin. Off. Prep.: Tinctura Vanillæ.

*Uses.*—As a flavoring agent in the form of Tincture, or triturated to a fine powder with sugar of milk or rock-candy—frequently with an admixture of Tonka.

## UNOFFICIAL AROMATIC DRUGS.

COM. NAME.	BOT. NAME.	PART USED.	CONSTITUENTS.
Achillæa (Yellow).	Achillæa millefolium.	Herb.	Vol. oil, achilleine, resin, tannin.
Angelica.	Archangelica officinalis.	Root.	Vol. oil, acids, resins.
Angelica (Amer).	Archangelica atropurpurea	Root.	(Same as above).
Apium.	Apium graveolens.	Fruit.	Vol. oil, fixed oil, etc.
Artemisia.	Artemisia vulgaris.	Herb.	Vol. oil, bitter principle.
Asarum (Canada Snake Root.)	Asarum Canadense.	R'zome,	Vol. oil 3%, resin, coloring matter.
Benzoin Bush.	Benzoin odoriferum.	Bk; Fruit.	Vol. oil, tannin.
Canella.	Canella alba.	Bark.	Vol. oil, resin, bit. prin.
Cataria.	Nepeta Cataria.	Herb.	Vol. oil, bitter prin'l.
Comptonia.	Comptonia asplendifolia.	Leaves.	Vol. oil, resin, tannin, alkaloid?
Cotula (Maywood)	Maruta Cotula.	Herb.	Vol. oil, anthemic and valeric acids, acrid fixed oil.
Erigeron (Fleabane).	Erigeron Canadensis.	Herb.	Vol. oil, bitter prin'l.
Gaultheria.	Gaultheria procumbens.	Leaves.	Vol. oil, 5% (methyl salicylate), ericolin, tannin, etc.
Glechoma.	Glechoma Hederaceæ.	Herb.	Vol. oil, bitter prin'l.
Golden Rod.	Solidago odora.	Herb.	Volatile oil.
Hyssop.	Hyssopus officinalis.	Herb.	Vol. oil, bitter principle, tannin.
Imperatoria.	Imperatoria ostruthium.	Root.	Vol. oil, Imperatorin.
Iris (orris).	Iris Florentina.	R'zome.	Vol. oil, resin, bitter extractive, starch.
Juniper.	Juniperus communis.	Twigs.	Vol. oil, resin.
Laurel.	Laurus nobilis.	Leaves.	Vol. oil and bitter prin'l
Lavender.	Lavandula vera.	flowers.	Vol. oil, 1½%, resin, tannin.
Levisticum (Lovage).	Levisticum officinale.	Root.	Vol. oil, bitter extractive, resins.
Marjoram.	Origanum marjorana.	Herb.	Volatile oil.
Micromeria.	Micromeria Douglassii.	Herb.	Volatile oil.
Origanum.	Origanum vulgare.	Herb.	Vol. oil 1%, resin, bitter principle.
Parsley.	Petroselinum sativum.	Root and Seed.	Vol. oil, apin.
Pimpernel.	Pimpinella saxifraga.	Root.	Vol. oil and acrid resin.
Rosmarinus.	Rosmarinus officinalis.	Leaves.	Vol. oil 1%, resin, tannin.
Rhus (aromatic).	Rhus aromatica.	Root-bk.	Vol. oil, resin, tannin.
Sandalwood.	Santalum album.	Wood.	Vol. oil, resin.
Sarsaparilla (False).	Aralia nudicaulis.	R'zome.	Vol. oil, and resin.
Spikenard (Amer).	Aralia racemosa.	R'z; Root.	Vol. oil and resin.
Thyme.	Thymus vulgaris.	Herb.	Vol. oil, resin.
Turmeric.	Curcuma longa.	R'zome.	Vol. oil, pungent resin.
Wintera.	Drimys Winteri.	Bark.	Vol. oil, tannin, pungent resin.
Xanthoxylum (Prickly Ash.)	Xanthoxylum fraxineum.	Fruits.	Vol. oil, resin.
Zedoaria.	Curcuma Zedoaria.	R'zome.	Vol. oil, pungent resin.

## Resins and Oleoresins.

Resins are solid, usually amorphous, vegetable products, commonly with a conchoidal fracture, soluble in alcohol and usually also in the fixed oils but not in water, transparent or semi-transparent, readily fusible, inflammable, and burning with a sooty flame, not volatilizing without undergoing chemical change and negatively electrified by friction. Some contain acids, and with the alkalies are capable of forming soaps; others are neutral, and can not be saponified.

*Composition.*—The Resins are complex bodies, being mostly mixtures of different compounds of Carbon, Oxygen and Hydrogen. Shellac, for instance, consists of five different resins and a coloring matter. Amber is a mixture of Succinic Acid and several resins; Sandarac consist of three resins, which differ in solubility, but are not soluble in water, and a fourth constituent, a bitter principle, which is soluble in water.

*Origin.*—The resins are widely distributed through the vegetable kingdom, there being very few plants that are entirely destitute of them, while some secrete them in large proportion. Sometimes they are diffused through all the tissues of the plant, sometimes they are collected together in certain parts, as in the heart-wood in Guaiac; sometimes they are accumulated in certain special secretion cells, and these cells may be isolated, collected together in masses, or coalescent, forming tubes or ducts; or these secretions may be poured into inter-cellular spaces, and these may be small isolated areas, or they may form tubes in the leaves, wood or bark, following the direction in length of the organ in which they occur.

The mode of formation of the resins is obscure, but they are probably to be regarded as degradation products, resulting from the partial breaking down of vegetable tissues. It has been observed in some instances that, as resin accumulates in a tissue, the cell-walls of that tissue become thinner and finally disappear. Resin would appear, therefore, to be, in these cases at least, the product of the *retrograde metamorphosis* of cellulose or lignin. But that the change is not immediate, but first into Volatile Oil and then into Resin, is indicated by the fact that most Volatile Oils, on standing exposed to light and air, partially change into Resin, and also by the fact that Resin appears always to exist in the plant associated with volatile oil.

Some of the resins are used medicinally but the larger portion of them are chiefly valuable for varnishes.

## THE OLEORESINS.

The Oleoresins, like the resins, are of vegetable origin, and consist of mixtures in various proportions of *resins* with *volatile oils*. They therefore partake of the characters of both.

The Oleoresins may be divided into:

(1) Natural Oleoresins to which belong *Copaiba*, the Turpentines and Pitches, and

(2) Pharmaceutical Oleoresins, a Class of Preparations made by extracting *Oleoresinous Drugs* with Ether and evaporation to a semi-liquid extract.

These are the only kind having the official title "Oleoresin" in the U. S. Ph., and are made from the following drugs: Aspidium, Capsicum, Cubeb, Lupulin, Pepper and Ginger. They are described with the Pharmaceutical Preparations in a following Lecture.

Only the *natural* Oleoresins will be here considered.

## COPAIBA.

*Copaiba*.—*Copaiba*, U. S.—Commonly called Balsam of *Copaiba*. The Oleoresin obtained from *Copaiba Langsdorffii*, Kuntze, and other species of *Copaifera*, by boring holes into the heart-wood; the oleoresin being contained in ducts, frequently of large size, in the interior of the trunk.

Light yellow or brownish yellow, transparent or somewhat turbid, viscid liquid, with a peculiar aromatic odor and an acrid, bitter, and nauseous taste. Sp. gr. from 0.94 to 0.99, increasing with age; soluble in strong alcohol, benzol, and carbon disulphide, fixed and volatile oils; insoluble in water but yields a transparent mixture with one-third its volume of ammonia water.

The principal kinds of *Copaiba* are:

• *Para* *Copaiba*, limpid, light-colored and transparent, and contains from 70 to 85 per cent of volatile oil.

*Rio Janeiro* and *Maranhão* *Copaiba* resemble each other closely; denser than *Para*; usually contain from 50 to 60 per cent of volatile oil.

*Maracaião* *Copaiba*, still denser, deeper colored, often somewhat turbid; does not usually, like the other *Copaibas*, yield a clear mixture with one-third of its volume of ammonia water; contains only from 20 to 40 per cent of volatile oil, and solidifies with magnesia.

*Adulterations*.—Castor and other fixed oils, turpentine and other volatile oils, and other oleoresins, as *Gurjun balsam*. Fixed oils are detected by the sticky residue left behind on evaporating the volatile oil, by the greasy area left around the resin when a drop of the suspected article has its volatile oil volatilized from paper, and by the fact that most fixed oils are insoluble in alcohol. Volatile oils are recognized usually by their odor when warmed.

The presence of "*Gurjun Balsam*" is detected by the violet coloration produced by the addition of 1 drop of a cold mixture of sulphuric and nitric acids to a solution of 1 drop of *copaiba* in 19 drops carbon disulphide.

*Constituents.*—Volatile oil; copaivic, oxycopaivic, or metacopaivic acid; various resins, and a bitter principle soluble in water.

*Uses.*—Expectorant, diuretic and stimulant usually in the form of Emulsion, Paste or Pill. Also applied externally.

*Off. Prep.*—Massa Copaiba, a compound of Copaiba with Magnesia.

*Gurjun Oleo-Resin*, commonly called Gurjun Balsam.—Product of *Dipterocarpus turbinatus*, and other species of the same genus of trees, indigenous to India and the Malay Archipelago.

Obtained by making deep incisions in the trunk, and then charring it, causing the oleoresin to flow freely.

It closely resembles the more viscid forms of Copaiba in odor, but to the taste is more bitter and not acrid. When heated to a temperature of about 130° C., it becomes gelatinous, and does not resume its fluidity on cooling. Sp. gr. from 0.95 to 0.96; entirely soluble in carbon disulphide, chloroform, and the volatile oils, but only partly so in alcohol, and petroleum benzin.

*Constituents.*—Gurjonic acid, resin and volatile oil.

*Uses.*—Similar to those of Copaiba.

#### THE TURPENTINES.

Several turpentines are used in pharmacy, and all but one of them, Cyprus turpentine, are the products of trees belonging to the natural order Coniferae. Cyprus turpentine is the product of one of the Anacardieae.

The Volatile Oils in all of them are identical in chemical structure, though different somewhat in odor. Their chemical formula when pure is  $C_{10}H_{16}$ .

*Common Turpentine.*—*Terebinthina*, U. S.—Commonly called “gum” or “pitch” turpentine. A concrete oleoresin obtained as an exudation from *Pinus palustris*, Miller, and other species of Pines.

In yellowish, opaque, tough masses, brittle in the cold, of a terebinthinate odor and taste, containing about 30 per cent of volatile oil and resin.

*Uses.*—Diaphoretic, diuretic, stimulant and astringent. Used externally in ointments and plasters. Its principal use is in the preparation of “turpentine” oil, which is obtained by distillation, the residue being “rosin.”

*Canada Turpentine.*—*Terebinthina Canadensis*, U. S.—A liquid or semi-liquid oleoresin obtained as an exudation from the Balsam Fir, *Abies balsamea*, Miller.

Transparent when pure, slightly yellowish or greenish, viscid, odor and taste similar to common turpentine, but more agreeable, with age hardening, and acquiring a distinct yellow color.

*Composition.*—Volatile oil and two resins, one readily soluble in alcohol, the other with difficulty.

*Uses.*—Stimulant, diaphoretic, diuretic. Mostly used externally. Used extensively as a mounting medium in microscopy.

*Venice Turpentine*.—*Terebinthina Veneta*.—Product of the European larch, *Larix Europea*. Secreted in the heart-wood, and is obtained by boring holes to the center of the tree and dipping the liquid out as it accumulates.

Dense, nearly colorless, transparent, fluorescent liquid of a terebinthinate odor and an aromatic, acrid, and bitter taste.

*Composition*.—Volatile oil, two or more resins, and succinic acid. Completely soluble in alcohol.

*Uses*.—Stimulant, diuretic and diaphoretic. Also used externally in ointments and plasters.

*Strasburg Turpentine*.—*Terebinthina Argentoratensis*. Product of *Abies pectinata*.

Resembles Canada Balsam in its composition, properties and uses. Odor more agreeable. Contains a small amount of succinic acid.

*Cyprian or Chian Turpentine*.—*Terebinthina Chia*.—Product of *Pistacia terebinthus*, natural order Anacardieæ. Obtained from incisions in the bark of the tree.

Transparent or nearly so, semi-fluid or hardened, brownish or greenish-yellow in color; taste somewhat bitter, odor balsamic, somewhat fennel-like.

*Composition*.—Volatile oil and two resins, one soluble in cold alcohol, the other insoluble.

*Uses*.—Similar to those of other turpentine.

*Burgundy Pitch*.—*Pix Burgundica*, U. S.—Exudation product of *Abies excelsa*, or Norway Spruce Fir, a native of Central and Northern Europe.

Hard, but yielding without fracture to slowly graduated pressure, semi-transparent or opaque, yellowish or brownish, fracture shining, conchoidal; odor aromatic; taste agreeable. Almost entirely soluble in glacial acetic acid or in boiling alcohol and partly soluble in cold alcohol.

*Composition*.—Volatile oil, probably  $C_{10}H_{16}$ , resin, and a little water.

*Uses*.—For ointments and plasters.

*Off. Prep.*.—*Emplastrum Picis Burgundicæ*; *Emplastrum Picis Cantharidatum*.

*Hemlock Pitch*.—*Pix Canadensis*.—Exudation product of common Hemlock, *Abies Canadensis*. Not official.

Dark reddish brown in color, with a weak terebinthinate, balsamic odor and resembles in its composition, properties and uses, Burgundy pitch.

*Tar*.—*Pix Liquida*, U. S.—Products of the destructive distillation of the wood of various species of Pine; was described with the products of destructive distillation of wood.

## THE RESINS.

The Resins may be divided into (1) Resins obtained from Oleoresins, by separation from the Oil by distillation, (2) natural exudations and (3) resins extracted from resinous Drugs. The latter class are treated with the Pharmaceutical Preparations in a subsequent Lecture.

To the first Class belong:

*Resin.*—*Resina, U. S.*—Common Rosin or Colophony.—The residue after distilling the volatile oil from the Oleoresin of Turpentine.

The residue while hot, is drawn off and passed through a series of strainers, when on cooling it constitutes the commercial "rosin." The color of the product varies according to the temperature at which the distillation takes place.

Transparent, light or dark amber colored masses, having a vitreous fracture, fusible at about 100°C., soluble in alcohol, ether, and in both volatile and fixed oils; odor and taste somewhat terebinthinate.

*Constituents.*—Chiefly abietic anhydride.

*Uses*—Mainly for ointments and plasters.

*Off. Prep.*—Ceratum Resinæ; Emplastrum Resinæ.

*Copaiba Resin.*—*Resina Copaibæ, U. S.*—Obtained from the Oleoresin of *Copaiba* by distilling off the volatile oil.

Amorphous, yellowish, or brownish-yellow brittle masses, soluble in alcohol, ether, carbon disulphide, benzol, and the volatile oils; odor similar to that of the oleoresin; the alcoholic solution is somewhat acrid and bitter, and acid in its reaction.

*Composition.*—A mixture of copaic acid and metacopalic acids with more or less neutral resin.

*Uses.*—Same as those of the oleoresin, which see.

To the Natural Resins belong the following:

Official: Guaiac and Mastiche.

Unofficial: Elemi, Amber and the following used almost exclusively for varnishes: Copal, Dammar, Sandarac, Lac and Asphalt.

*Guaiac.*—*Guaiaci Resina, U. S.*—Product of *Guaiacum officinale*, and *G. sanctum*, West India and South American trees, belonging to the Nat. Ord. Zygophylleæ. It is most abundant in the heart-wood.

Obtained partly as natural exudation, partly from incisions in the trunks of living trees, and partly by setting fire to billets of wood that have been channeled on one side, the resin as it fuses flowing out along the groove.

In tears or irregular masses more or less intermixed with splinters of wood and particles of dirt. In thin pieces, transparent, lustre vitreous, fracture brittle and somewhat conchoidal, color greenish or reddish-brown, soluble in alcohol and caustic potassa, but not in oil of turpentine or benzol. The freshly prepared powder is whitish, but soon turns green on exposure to the air, and its powder or solution is rapidly turned green by nitric acid and other powerful oxidizing agents.

*Composition.*—Complex, consisting of guaiacic acid, guaiac yellow, guaiaretic acid, betaresin, a small proportion of gum, ash, etc.

*Uses.*—Stimulant, diuretic and alterative, sometimes in the form of Mixture or Emulsion.

*Off. Prep.*—Pil. Antimonii comp.. Tinctura Guaiaci; Tinctura Guaiaci Ammoniata.

*Mastic.*—Mastiche, U. S.—Product of *Pistacia Lentiscus*. Nat. Ord., *Anacardieæ*, small tree, indigenous to the basin of the Mediterranean. Obtained from vertical incisions into the bast layer of the trunk and larger branches

In rounded or elongated tears about the size of peas, brittle, with a conchoidal fracture, transparent when free from the powdery dust which usually adheres to them, of a light yellow color, partly soluble in alcohol, entirely so in ether and the volatile oils, the alcoholic solution acid in its reaction, odor faintly balsamic, taste somewhat terebinthinous, softening in the mouth.

*Constituents.*—Mastichic acid, about 90%, soluble in alcohol; Masticin, soluble in hot alcohol; and a trace of volatile oil.

*Uses.*—Mild astringent and masticatory; also for varnishes and cements.

*Off. Prep.*—Pilulae Aloes et Mastiches.

*Elemi.*—A resinous exudation obtained from various sources:

*Manila Elemi*, exudation from *Canarium commune*, Nat. Ord. Burseraceæ.

*Brazilian Elemi*, from *Icica Icicariba* and other species of the same genus.

*Mexican Elemi*, supposed to be the product of *Amyris elemifera*; and

*Mauritius Elemi*, from *Colophonia Mauritiana*.

*Manila Elemi* is the most important. Crystalline, yellowish, soft, friable when old; taste pungent, disagreeable, bitter; odor aromatic, balsamic.

*Composition.*—Volatile oil ( $C_{10}H_{16}$ ), elemic acid, crystalline resin, and amorphous resins.

*Uses.*—Stimulant and irritant; externally in ointment and plasters.

*Copal Resin.*—Chiefly found fossil in Zanzibars and other parts of Africa, but is also obtained from various tropical leguminous trees.

Large irregular pieces, usually finely verrucose at the surface, hard, transparent or translucent, resembling amber; inodorous, tasteless, difficultly fusible, fracture conchoidal.

*Constituents.*—Several different resins.

*Dammar Resin*, or Dammara.—Obtained from two different species of coniferous trees, *Dammara Orientalis*, East Indies; and *Dammara Australis*, New Zealand. It is a spontaneous exudation. The New Zealand Dammar or "Kauri Gum" sometimes occurs fossil.

Roundish, transparent, yellowish, inodorous, tasteless masses, that have a glossy, conchoidal fracture. It is not so hard as copal, melts at a temperature somewhat above 100 C., is somewhat soluble in alcohol, but more so in chloroform and benzol.

*Constituents.*—Several different resins.

*Uses.*—Sometimes in preparation of plasters, more commonly for varnishes.

*Sandarac Resin*, or Sandarac.—Spontaneous exudation from the stem of a small African tree, *Callitris quadrivalvis*; Nat. Ord. Coniferæ.

Resembles mastiche and is sometimes used to adulterate it. It differs in occurring in more elongated tears, in becoming powdered when masticated, and in being almost completely soluble in alcohol.

Three different resins and a bitter principle soluble in water.

*Shellac*, or *Lacca*.—Product of a variety of East Indian and a few Mexican plants. An exudation produced by the puncture of a hemipterous insect, the female of *Coccus lacca*. The lac of commerce comes chiefly from India, and the most important trees which produce it are a spurge, the *Aleuritis laccifera*, and a fig, the *Ficus Indica*.

Lac occurs in the following forms: *Stick lac* consists of the thin twigs of the tree covered with the resinous exudation. *Sid lac*, of the glossy fragments that have been detached from the twigs; and *Lump lac*, that obtained by boiling the stick or seed lac with water, and melting the product into cakes.

*Shellac*, of reddish or orange colored transparent flakes, brittle, tasteless and glossy, and produced in the same way as lump lac, only dried or hardened in thin plates instead of in masses.

*Constituents*.—Complex; five different resins, and some coloring matter.

*Uses*.—Chiefly in the preparation of varnishes and sealing wax.

*Amber*, or *Succinum*.—Fossil product of an extinct coniferous tree, *Pinitis succinifer*, and probably also of other species. Obtained principally from the shores of the Baltic where it is cast up by the waves.

Hard, brittle, transparent, or translucent, yellowish or reddish-brown irregular masses; melts at 288 C., and at that temperature gives off succinic acid. Scarcely soluble at all in alcohol, ether, or the volatile oils, but somewhat soluble in chloroform.

*Constituents*.—Various resins and succinic acid.

*Uses*.—Source of oil of amber and succinic acid.

*Asphalt*, or *Asphaltum*, like amber, is a fossil resin.

It is one of the series of petroleum products, and forms extensive deposits in some parts of the world, as in the Island of Trinidad and Utah. Used in the manufacture of varnishes.

# The Gum-Resins and Balsams.

## THE GUM-RESINS.

The Gum-Resins include those milky exudations of plants which contain a Gum *soluble* in water and a Resin *insoluble* in water but soluble in alcohol. They also often, but not always, contain volatile oils. They may, therefore, be conveniently divided into two groups:

(1) Those which contain volatile oil:

Ammoniac, Asafoetida and Myrrh are official. Galbanum, Bdellium, Olibanum, Opopanax and Sagapenum are unofficial.

(2) Those which do not contain volatile oil are:

Gamboge, Scammony and Elastica, official; Euphorbium, unofficial.

*Ammoniac*.—Ammoniacum U. S.—Spontaneous exudation product from stem of Dorema Ammoniacum, Don; Nat. Ord. Umbelliferae.

Distinct or agglutinated tears, light yellowish-brown externally, milk-white internally, softens by the heat of the hand; has a bitter and disagreeable acrid taste, and with water forms a milk-white emulsion.

A form which comes in cakes and consists of tears imbedded in a brown mass; is too impure for medicinal use.

*Composition*.—Gum 18 to 28 per cent, resin about 70 per cent, volatile oil from  $\frac{1}{2}$  to 4 per cent.

*Uses*.—Expectorant and stimulant.

*Off. Prep.*.—Empl. Ammoniac c. Hydrarg.. Emulsum Anmoniaci.

*Opopanax* gum-resin. Product of another umbelliferous plant, a native of Southern Europe, the Opopanax Chironium is obtained by making incisions in root or lower part of stem.

Irregular masses, angular or rounded, friable, reddish or yellowish brown, odor disagreeable, taste balsamic, bitter. Similar in properties and uses to ammoniac.

*Asafoetida*.—Asafoetida, U. S.—Exudation product from two different species of Ferula foetida, Regel; a native of Afghanistan and Turkestan. Obtained by making incisions in the root.

It occurs in the form of *tears* nearly distinct, or more or less agglutinated in masses, more commonly, however, as

*Amygdaloid* asafoetida, irregular pieces made up of tears imbedded in a sticky yellowish or brownish gray mass, more or less impure from vegetable fragments and earthy matters. When the mass is freshly broken the tears are white, but on exposure changing to pink and then to brown.

*Liquid asafætida* is a sticky semifluid, more or less impure mass, at first light-colored but gradually turning brown on exposure.

*Stony asafætida* is a very impure variety, consisting of a little of the gum-resin mixed with a large proportion of calcium sulphate and other impurities.

Good asafætida should contain 60 per cent of matter that is soluble in alcohol; it has a strong alliaceous odor and bitter, acrid taste; forms a milky emulsion with water, and when moistened with alcohol and afterward with chlorhydric acid a greenish color is produced.

*Composition.*—Gum 20 to 30 per cent, resin 50 to 70 per cent, 3 to 9 per cent volatile oil and various impurities.

*Uses.*—Stimulant, antispasmodic, expectorant, laxative.

*Off. Prep.*—Emulsum Asafætidæ, Pil. Aloes et Asafætidæ; Pil. Asafætidæ; Tinctura Asafætidæ.

*Galbanum.*—*Galbanum.*—Spontaneous exudation from stem of *Ferula galbaniflua* and other species of the same genus of Umbelliferous plants. There are two kinds: in tears and lump galbanum.

The tears are small, from the size of a pin-head to that of a pea or larger, mostly agglutinated into a hard mass. Yellowish-brown or greenish-brown outside, whitish or yellowish inside, peculiar balsamic odor, acrid bitterish taste. Treated with alcohol and then with chlorhydric acid, it turns purplish.

*Lump* galbanum sometimes incloses tears, is sometimes soft, has a somewhat different color and does not change color by alcohol and chlorhydric acid. Probably derived from a different species of plant.

*Composition.*—Gum 15 to 20 per cent, resin 60 to 66 per cent, volatile oil 6 to 9 per cent.

*Uses.*—Antispasmodic, stimulant, expectorant.

*Uses.*—Emplastrum Asafætidæ, Emplastrum Galbani, Pilulæ Galbani compositæ, formerly official U. S. Ph. '80.

*Myrrh.*—*Myrrha*, U. S.—Spontaneous exudation from bark of *Commiphora Myrrha*, Engler; Nat. Ord. Burseraceæ, a tree inhabiting Arabia and Northeastern Africa.

Dusty, reddish or yellowish-brown masses of irregular tears, odor aromatic, taste bitter, acrid. It yields a brownish-yellow emulsion with water, its alcoholic solution acquires a purple coloration with nitric acid.

*Composition.*—Gum 40 to 60 per cent, resin 25 to 40 per cent, volatile oil, bitter principle and ash.

*Uses.*—Given internally and applied externally. Stimulant, expectorant, emmenagogue.

*Off. Prep.*—Mistura Ferri composita; Pilulæ Aloes et Myrrhæ; Tinctura Aloes et Myrrhæ; Tinctura Myrrhæ.

*Bdellium.*—Similar to myrrh. Product of *Balsamodendron Mukul*, a native of East India and West Africa.

It is best distinguished from myrrh by testing the tincture with nitric acid. Myrrh acquires a purple hue while bdellium does not. Used mostly in plasters.

*Olibanum* or Frankincense.—Exudes from incisions made in bark

of *Boswellia Carterii* and other species of the same genus, Nat. Ord. Burseraceæ. The trees are natives of Arabia and Eastern Africa.

Light red or yellowish, translucent, externally dusty tears of variable size and shape. They soften when held in the mouth, have a bitterish and balsamic taste and a balsamic odor. Lump olibanum is less pure, being gathered from the ground.

*Composition.*—Gum about 30 per cent, resin 60 to 70 per cent, volatile oil and a bitter principle.

*Uses.*—Chiefly for plasters and fumigations, sometimes internally. Expectorant, tonic, stimulant.

#### GUM-RESINS CONTAINING NO VOLATILE OIL.

*Gamboge.*—Cambogia, U. S.—Obtained by making incisions into the bark of *Garcinia Hanburii*, Nat. Ord. Guttiferæ, a small tree native to Cochin China, Cambodia and Siam.

In sticks or cakes, the former preferred on account of its being less liable to adulteration. Sticks cylindrical, sometimes hollow; surface striated from the impressions of the bamboo, in the hollow stems of which the gum resin is collected; fracture smooth, conchoidal, orange red in color, inodorous, taste unpleasantly acrid, dust sternutatory. A good quality yields a bright yellow powder and also a bright yellow emulsion when triturated with water.

*Composition.*—Gum 16 to 20 per cent and resin about 80 per cent, besides some water and impurities.

*Uses.*—In combination with other medicine as a hydragogue cathartic.

*Off. Prep.*—Pilulae Catharticae compositæ.

*Scammony.*—Scammonium, U. S.—Dried milk-juice of *Convolvulus Scammonia*, Nat. Ord. Convolvulaceæ, a native of Western Asia. Obtained by cutting off the top of root and scraping away the exuding milk-juice.

Dark greenish or blackish irregular masses, or regular cakes, breaking with an angular fracture, a resinous lustre; powdered it possesses a greenish cast and yields with water a dark greenish emulsion; odor somewhat like cheese, taste acrid,

*Composition.*—Gum 5 to 15 per cent, resin 80 to 90 per cent, and various impurities. Liable to be adulterated with starch, chalk and with various resins.

*Uses.*—As hydragogue cathartic.

*Off. Prep.*—Resina Scammonii.

*Euphorbium.*—Exudation from incisions in the stem of *Euphorbia resinifera*, a cactus-like shrub, native to the mountains of Morocco.

Dull brownish yellow, somewhat translucent, globular, conical or irregular masses, dust violently sternutatory, taste very acrid. Not completely soluble in any simple solvent; does not completely emulsify in water.

*Composition.*—Gum 18 per cent, euphorbion and another resin, malates, and various impurities.

*Uses.*—Externally as rubefacient, vesicant and suppurant. If taken internally it acts as a violent and dangerous purgative and emetic.

*India Rubber*.—Elastica, U. S.—Caoutchouc.—The prepared milk-juice of various species of Hevea. Nat. Ord., Euphorbiaceæ; known in commerce as Para Rubber.

It is obtained from incisions through the bark and dried, on moulds so as to furnish hollow balls, or in solid roundish pieces.

Brown or brownish-black, internally lighter colored, insoluble in water, dilute acids, solutions of alkalies or alcohol; soluble in chloroform, carbon disulphide, oil of turpentine, benzin and benzol. It is lighter than water and melts at 125° C.

*Uses*.—Its solution in Chloroform as a cement and sometimes as a surgical dressing. Mixed with Sulphur and heated it is rendered insoluble and unaffected by heat, *vulcanized*; a useful material for the construction of surgical appliances, etc.

#### THE BALSAMS.

The term balsam is used very frequently in a loose, general sense to designate certain resins, oleoresins and mixtures of various kinds, differing widely in composition and properties, but supposed to possess healing virtues.

The term is here restricted to those liquid, semi-liquid or solid vegetable products that contain, in addition to a *resin* or *oleoresin*, benzoic or cinnamic acids, or both.

The official Balsams included under this definition are: Benzoin, Peru, Tolu and Styrax.

*Benzoin*.—Benzoinum, U. S.—A solid balsam from *Styrax Benzoin*, a tree native to Sumatra, Java and Siam. Exudes from incisions made through bark of tree.

Several varieties, the better consisting of opaque, milk-white tears, agglutinated in masses, the mass being yellowish or grayish-brown, but inferior kinds contain few tears and a large proportion of bark and chips of wood. It is almost wholly soluble in 5 parts of warm alcohol and in solutions of the fixed alkalies.

*Sumatra Benzoin*, in brown-gray masses, containing a variable proportion of milky-colored tears.

*Siam Benzoin*, in red-brown translucent masses with few or many tears and an agreeable vanilla-like odor.

*Penang Benzoin*, sometimes very similar to the Sumatra variety, but at other times more resembling storax in appearance and odor.

*Composition*.—Benzoic and cinnamic acids, various resins, and, in some varieties, vanillin. Cinnamic acid is sometimes absent.

*Uses*.—Stimulant, expectorant. Also in preparation of pastiles, dentifrices and perfumes.

*Off. Prep.*.—*Adeps Benzoinatus*, *Tinctura Benzoini*, *Tinctura Benzoini composita*.

*Peru Balsam.* — Balsamum Peruvianum, U. S.—Derived from Toluifera Pereira, Baillon, a tree growing in West Brazil, North-western coast of South America and Central America.

Molasses-colored, semi-liquid, red-brown, and transparent when seen in thin layers; sp. gr. 1.135 to 1.150; odor agreeable, aromatic, somewhat smoky; taste, warm, bitterish, afterward acrid. Miscible in all proportions with absolute alcohol, chloroform or glacial acetic acid; only partially soluble in ether & benzin; completely soluble in 5 parts of alcohol.

*Composition.*—Benzoic and cinnamic acids, benzylic benzoate and cinnamate benzylic alcohol and resin.

*Adulterations.*—Alcohol, fixed oils, copaiba, turpentine, rosin, etc. [For tests of purity see U. S. Ph.]

*Uses.*—Externally as ointment; internally, stimulant and expectorant; also as a basis for perfumes.

*Tolu Balsam.* — Balsamum Tolutanum, U. S.—Product of a Leguminous tree, Toluifera Balsamum, Linne. A native of Central America, Venezuela, and New Granada.

It is obtained by scarifying the bark of the trees and collecting the exudation in "calabashes."

Liquid or semi-liquid when fresh, hardening with age, but still readily softening in the mouth, yellowish or reddish-brown in color, in thin layers transparent; when examined microscopically, showing crystals of cinnamic acid; odor agreeably aromatic, somewhat resembling vanilla; taste aromatic; completely soluble in alcohol and chloroform, solutions of fixed alkalies and almost so in ether, but insoluble in carbon disulphide and petroleum benzin.

*Composition.*—Benzoic and cinnamic acids, two resins differing in their solubility in alcohol, toluene, and benzylic benzoate and cinnamate.

*Adulterations.*—Turpentine, which may be detected by means of sulphuric acid, which turns pure tolu balsam a cherry red, but bleaches that which contains turpentine.

*Uses.*—Expectorant, stimulant. Used by perfumers, and in the manufacture of pastiles.

*Off. Prep.*—Syrupus Tolutanus; Tinctura Benzoini comp.; Tinctura Tolutana.

*Storax Balsam.* — Styrax, U. S.—Product of the Liquidamber Orientalis. Nat. Ord., Hamamelaceae, inhabiting the Southwestern part of Asia Minor. Extracted from the inner bark of the tree by boiling in water.

Consistency of thick syrup; opaque from containing finely divided particles of water, separated by standing into two layers, one heavier and darker colored, the other lighter and containing most of the water; odor strong, agreeable, balsamic. Soluble in alcohol, ether, and carbon disulphide, insoluble in cold

petroleum benzin, but hot benzin dissolves out the styracin and cinnamic acid which are deposited in crystals on cooling.

*Composition.*—Benzoic and cinnamic acids, styracin, storesin, resins, etc.

*Uses.*—Stimulant, diuretic, or expectorant; also in *Tinctura Benzoini Composita*.

*Liquidamber styraciflua*, the "Sweet Gum Tree," of the Southern United States, exudes a similar balsam. It is usually solid.

*Dragon's Blood.*—*Resina Draconis*.—Exudation from ripening fruit of *Dæmonorops Draco*, a species of Palm, native to the Malay Archipelago.

Solid, dark, red-brown, in tears, rounded masses, sticks, or irregular cakes, transparent in thin pieces, aromatic, and with a benzoin-like odor when heated; readily soluble in alcohol, benzol and turpentine.

*Composition.*—Resins, benzoic or cinnamic acid. Sometimes the one and sometimes the other acid is present, and sometimes both are wanting.

*Uses.*—Astringent, stimulant. Employed for coloring varnishes and tinctures, and in plasters.

#### BALSAM ACIDS.

*Benzoic Acid.*— $\text{HC}_7\text{H}_5\text{O}_2$ .—*Acidum Benzoicum*, U. S.—A mono-basic acid obtained by sublimation from Benzoin, or produced artificially from Toluol.

Only from 7 to 8% of the acid is obtained by sublimation, nearly an equal amount left in the benzoin being produced by boiling the residue with milk of lime, filtering and supersaturating the hot filtered liquid with Hydrochloric Acid. The crystals thrown out are purified by dissolving them in hot alcohol and filtration through animal charcoal, or by sublimation.

Soluble in 500 parts of water at 15° C., in 15 parts of boiling water, and in 2 parts of alcohol; completely volatilized without change when heated on platinum foil; heated with 3 parts of quicklime in a test tube, it evolves the odor of benzol.

*Uses.*—In medicine chiefly in genito-urinary diseases; dose from 3 to 6 decg., also as an antiseptic in surgery.

*Cinnamic Acid.*— $\text{HC}_9\text{H}_7\text{O}_2$ .—An acid quite similar to Benzoic Acid is derived chiefly from Cinnamon Oil, which consists of cinnamic aldehyde.

## Resinous Drugs, Group IV.

This group includes those vegetable drugs whose virtues are chiefly or wholly due to the presence of an acrid or bitter resin, or to extractive matter, either associated or not with a volatile or acrid fixed oil.

Some few contain glucosides, alkaloids, or other principles, but these are not regarded as possessing any considerable medicinal importance.

The Resinous drugs require alcoholic menstrua for extraction and like the aromatic drugs their preparations precipitate with water. The process for preparing the Resin of *Podophyllum*, by pouring a concentrated alcoholic Tincture of the drug into Water, is one of the best illustrations of their behavior when mixed with water or aqueous liquids. This pharmaceutical incompatibility may be modified or prevented by the intervention of Sugar or Mucilage, which serves to suspend the resinous matter in liquid mixtures.

*Absinthium*.—*Absinthium*, U. S.—Wormwood, leaves and tops of *Artemisia absinthium*, Linne. Nat. Ord., Compositæ. Constituents: Vol. oil, one per cent; absinthin, tannin, resin, etc. Preparation: *Vinum aromaticum*, U. S. Ph. '80.

*Uses*.—*Tinctura Absinthii* and *Abstractum Absinthii* Ph. Ger., prepared with diluted alcohol; also largely used in various "Bitters."

*Arnica Flowers and Root*.—*Arnicæ Flores* and *Arnicæ Radix*, U. S.—Flowers and Root of *Arnica montana*, Linne. Nat. Ord., Compositæ. Constituents: Vol. oil (root 1 per cent), inulin, both tasteless and acrid resins, arnicin, etc. Off. Prep.: *Tinctura Arnicæ Florum*; *Extractum Arnicæ Radicis*; *Extractum Arnicæ Radicis Fluidum*; *Tinctura Arnicæ Radicis*.

*Asclepias*.—*Asclepias*, U. S.—*Pleurisy Root*.—Root of *Asclepias tuberosa*, Linne. Nat. Ord., Asclepiadæ. Constituents: Bitter principle, resins, tannin, etc. Off. Prep.: *Extractum Asclepiadis Fluidum*.

*Uses*.—As Infusion in rheumatic affections, and, as its name implies, in pleurisy.

*Aspidium*.—*Aspidium*, U. S.—Rhizome of *Dryopteris filix mas*, and of *Dryopteris marginalis*, Gray. Nat. Ord., Filices. Constituents: Fixed oil, six per cent; filicic acid, filitannic acid, etc. Off. Prep.: *Oleoresina Aspidii*.

*Uses.*—For the removal of tapeworm, ten to twenty minims of the Oleoresin, administered upon a fasting stomach, and followed with a purgative.

*Buchu.*—(See Group 3.)

*Cusso.*—Cusso, U. S.—Brayera, '80.—Kousso. Female inflorescence of Hagenica Abyssinica, Gmelin. Nat. Ord., Rosaceæ. Constituents: Bitter acrid kousinresin about six per cent. tannin and tasteless resin. Off. Prep.: Extractum Cusso Fluidum.

*Uses.*—For the removal of tapeworm, either alone or combined with other agents in the form of Infusion which should not be strained.

*Indian Cannabis.*—Cannabis Indica, U. S.—Flowering tops of a female plant of an East Indian variety of Cannabis sativa, Linne. Nat. Ord., Urticaceæ. Constituents: Volatile oil, several resins and alkaloids. Off. Prep.: Extractum Cannabis Indicæ; Extractum Cannabis Indicæ Fluidum; Tinctura Cannabis Indicæ.

*Uses.*—Cannabin Tannate is a compound of the active principle with tannic acid, and is said to represent the medicinal virtues of "Indian Hemp."

*Cascara Sagrada.*—Rhamnus Purshiana, U. S.—The bark of Rhamnus Purshiana, De Candolle. Nat. Ord., Rhamnaceæ. Constituents: Several resins. Off. Prep.: Extractum Rhamni Purshianæ Fluidum.

*Uses.*—As a gentle laxative especially in habitual constipation. Also used in the form of Infusion and Extract representing five times the drug. The so-called tasteless preparations made by treating the drug with magnesia previous to extraction are not reliable.

*Caulophyllum.*—Caulophyllum, U. S.—Blue Cohosh.—Rhizome and rootlets of Caulophyllum thalictroides, Michx. Nat. Ord., Berberideæ. Constituents: Resins, saponin.

*Uses.*—Caulophyllin, a so-called resinoid, is prepared by precipitating an alcoholic tincture in water, washing, drying and powdering the precipitated resin. Owing to the saponin Caulophyllum contains, due care should be observed in the process of powdering, as it is a violent sternutatory.

*Chamomile.*—Anthemis, U. S.—Flower heads of Anthemis nobilis, Linne. Nat. Ord., Compositæ. Constituents: Vol. oil, bitter principle, etc.

*Uses.*—An ingredient in Bitters for domestic use; also as Infusion.

*Cimicifuga.*—Cimicifuga, U. S.—Black Snakeroot. Rhizome and rootlets of Cimicifuga racemosa, Elliott. Nat. Ord., Ranunculaceæ. Constituents: Resin, acrid principle, and a peculiar acid. Off. Prep.: Extractum Cimicifugæ; Extractum Cimicifugæ Fluidum; Tinctura Cimicifugæ.

*U.*—Cimicifugin, or macrotyn, a resinoid prepared by precipitating the alcoholic tincture in water, washing, drying and powdering the precipitated

**resin**; also as Decoction and Infusion, and solid Extract, which represents ten times the strength of the crude drug.

**Cotton Root Bark**.—*Gossypii Radicis Cortex*, U. S.—Bark of root of *Gossypium herbaceum*, Linne, and other species of *Gossypium*. Nat. Ord., Malvaceæ. Constituents: Resins, coloring matter, fixed oil, and a peculiar principle similar to tannin. Off. Prep.: *Extractum Gossypii Radicis Corticis Fluidum*.

**Uses**.—Sometimes in Decoction and Extract. Liquid preparations of cotton-root bark are liable to gelatinize, which may be prevented by using strong alcohol as a menstruum.

**Cubeb**.—(See Group 3.)

**Cypripedium**.—*Cypripedium*, U. S.—Ladies' Slipper.—Rhizome and rootlets of *Cypripedium pubescens*, Willd., and *C. parviflorum*, Salisbury. Nat. Ord., Orchideæ. Constituents: Volatile oil, resins, etc. Off. Prep.: *Extractum Cypripedii Fluidum*.

**Eucalyptus**.—(See Group 3.)

**Frangula**.—*Frangula*, U. S.—Buckthorn.—Bark of *Rhamnus frangula*, Linne. Nat. Ord., Rhamnaceæ. (Should be collected one year, at least, before using.) Constituents: Resin, bitter principle, emodin and frangulin. Off. Prep.: *Extractum Frangulæ Fluidum*.

**Garlic**.—*Allium*, U. S.—Bulb of *Allium sativum*, Linne. Nat. Ord., Liliaceæ. Constituents: Volatile oil one-fourth per cent; mucilage thirty-five per cent, etc. Off. Prep.: *Syrupus Allii*.

**Ginger**.—(See Group 3.)

**Grindelia**.—*Grindelia*, U. S.—Leaves and flowering tops of *Grindelia robusta*, Nuttall, (and *G. squarrosa*, Dunal). Nat. Ord., Compositæ. Constituents: Volatile oil, resin, and bitter extractive. Off. Prep.: *Extractum Grindeliae Fluidum*.

**Guaiacum Wood**.—*Guaiaci Lignum*, U. S.—*Lignum vitae*. Heartwood of *Guaiacum officinale* and *G. sanctum*, Linne. Nat. Ord., Zygophylleæ. Constituents: Resin and extractive matter.

**Uses**.—In Decoction; as a constituent of *Syrup Sarsaparilla comp.*, and in Species *Lignorum Ph. Ger.*

**Hamamelis**.—*Hamamelis*, U. S.—Witch Hazel.—Leaves of *Hamamelis Virginiana*, Linne. Nat. Ord.: Hamamelaceæ. (Leaves should be collected in autumn while still green.) Constituents: Tannin and bitter extractive. Off. Prep.: *Extractum Hamamelidis Fluidum*.

**Uses**.—In conjunction with the bark for the preparation of Distilled Extract of Witch Hazel by distillation with water, *Aqua Hamamelidis*. Nat. Form

**Inula**.—*Inula*, U. S.—Elecampane.—Root of *Inula Helenium*,

*Linne.* Nat. Ord., Compositæ. Constituents: Inulin, helenin, bitter extractive, and acrid resin.

*Iris.*—Iris, U. S.—Blue Flag.—Rhizome and rootlets of *Iris versicolor*, Linne. Nat. Ord., Irideæ. Constituents: Volatile oil, acrid resin. Off. Prep., Extractum Iridis; Extractum Iridis Fluidum.

*Uses.*—Iridin, a resinoid, prepared by precipitating the alcoholic tincture in acidulated water, washing, drying, and powdering the precipitated resin. Iris is also a constituent of Compound Syrup of Stillingia.

*Jalap.*—Jalapa, U. S.—Tuberous root of *Ipomœa Jalapa*, Nuttall. Nat. Ord., Convolvulaceæ. Constituents: Resins about fifteen per cent. Off. Prep.: Extractum Jalapæ; Pulvis Jalapæ Compositus; Resina Jalapæ.

*Uses.*—Resin of Jalap or "Jalapin" (prepared in the same way as the foregoing) is soluble in ether to the extent of ten per cent. The insoluble portion is termed convolvulin, and represents the medicinal virtue of Jalap. The U. S. Ph. directs that Jalap should yield not less than twelve per cent of resin. The principal use of Jalap is in the form of Extract in Comp. Cathartic Pills.

*Kamala.*—Kamala, U. S.—Hairs and glands from capsules of *Mallotus Phillipensis*, Mueller Arg. or *Rottlera tinctoria*, Roxburgh. Nat. Ord., Euphorbiaceæ. Constituents: Resins eighty per cent, rotterlin.

*Uses.*—As a remedy for Tænia and other intestinal worms, either alone or associated with other agents.

*Lappa.*—Lappa, U. S.—Burdock.—Root of *Arctium Lappa*, Linne. Nat. Ord., Compositæ. Constituents: Inulin, bitter extractive, mucilage, resin. Off. Prep.: Extractum Lappæ Fluidum.

*Uses.*—A tincture of Burdock fruit, twenty per cent, with seventy per cent alcohol, as an internal remedy in certain skin diseases.

*Lupulin.*—Lupulinum, U. S.—Glandular powder obtained from the strobiles of *Humulus lupulus*, Linne. Nat. Ord., Urticaceæ. Constituents: Volatile oil three per cent, resin, lupamaric acid, etc. Off. Prep.: Extractum Lupulini Fluidum; Oleoresina Lupulini.

*Uses.*—Chiefly in pills; made into a mass by the addition of a little ether.

*Marrubium.*—(See Group 3.)

*Matico.*—Matico, U. S.—Leaves of *Piper Angustifolium*, R. & P. Nat. Ord., Piperaceæ. Constituents: Volatile oil one and a half per cent, pungent resin, artanthic acid, tannin. Off. Prep.: Extractum Matico Fluidum; Tinctura Matico and an unofficial Infusion.

*Matricaria.*—Matricaria, U. S.—German Chamomile.—Flower heads of *Matricaria Chamomilla*, Linne. Nat. Ord., Compositæ.

**Constituents:** Volatile oil one-fourth per cent, anthemic acid, anthe-midin, bitter extractive.

**Uses.**—As a substitute for English or Roman Chamomile, to which, however, it is said to be inferior.

**Mezereum.**—Mezereum, U. S.—Bark of Daphne Mezereum, Linne, and other species of the same genus. Nat. Ord., Thymelæaceæ. Constituents: Soft acrid resin, daphnin and volatile principle. Off. Prep.: Decoctum Sarsaparillæ compositum; Extractum Sarsaparillæ compositum fluidum; Extractum Mezerei Fluidum.

Mezereum, when being powdered, produces a very irritating dust; it may be prevented by sprinkling a little alcohol upon the bark.

**Phytolacca Berry.**—Phytolaccæ Fructus, U. S.—Poke Berry.—Fruit of Phytolacca decandra, Linne. Nat. Ord., Phytolaccaceæ. Constituents: Acrid principle, sugar, gum, etc. Off. Prep.: Extractum Phyto-laccæ Fluidum.

**Phytolacca Root.**—Phytolaccæ Radix, U. S.—Poke Root. Root of Phytolacca decandra, Linne. Nat. Ord., Phytolaccaceæ. Constituents: Acrid principle, resin, tannin, etc.

Neither is much employed except by physicians of the Eclectic School of Medicine.

**Podophyllum.**—Podophyllum, U. S.—May Apple. Rhizome and rootlets of Podophyllum peltatum, Linne. Nat. Ord., Berberideæ. Constituents: Resins five per cent. Off. Prep.: Extractum Podophylli; Extractum Podophylli Fluidum; Resina Podophylli.

**Uses.**—Chiefly in the form of Resin, or Podophyllin, in pills, either alone or combined with other cathartics or agents to modify its action, *i. e.*, extract hyoscamus.

**Pulsatilla.**—Pulsatilla, U. S.—Herb of Anemone Pulsatilla, and A. pratensis, Linne. Nat. Ord., Ranunculaceæ. (Should be collected soon after flowering, carefully dried, and not kept more than one year.) Constituent: Volatile acrid principle. Preparations: Unofficial Fluid Extract and Tincture.

**Uses.**—The Homeopathic Tincture prepared 1 part in 10 of alcohol.

**Pumpkin Seed.**—Pepo, U. S.—Seeds of Cucurbita Pepo, Linne. Nat. Ord., Cucurbitaceæ. Constituents: Fixed oil fourty-four per cent, acrid resin.

**Uses.**—Emulsion as a tænifuge; two to four ounces are beaten with some sugar and triturated with water or milk; it should not be strained, as, according to some authorities, its efficiency in expelling the worms is due to the perisperm of the seed, which would be rejected by straining.

**Pyrethrum.**—Pyrethrum, U. S.—Pellitory. Root of Anacyclus Pyrethrum, De Candolle. Nat. Ord., Compositæ. Constituents:

**Acrid resin, bitter principle, inulin, fixed oil.** Off. Prep.: Tinctura Pyrethri.

*Uses.*—As an ingredient in Toothache Pills, Ph. Ger. The ground flowers of Pyrethrum roseum, known as "Persian Insect Powder," for the destruction of insects.

*Sambucus.*—(See Group 3.)

*Savine.*—Sabina, U. S.—Leafy tops of Juniperus Sabina, Linne. Nat. Ord., Coniferæ. Constituents: Volatile oil two per cent, resin, tannin. Off. Prep.: Extractum Sabinae Fluidum.

*Scutellaria.*—(See Group 10.)

*Serpentaria.*—Serpentaria, U. S.—Virginia Snake root. Rhizome and rootlets of Aristolochia Serpentaria, Linne, and A. reticulata, Nuttall. Nat. Ord., Aristolochiaceæ. Constituents: Volatile oil one-half per cent, bitter principle, tannin. Off. Prep.: Extractum Serpentariae Fluidum; Tinctura Cinchonæ compositæ; Tinctura Serpentariae.

*Stillingia.*—Stillingia, U. S.—Queen's Root. Root of Stillingia sylvatica, Linne. Nat. Ord., Euphorbiaceæ. Constituents: Pungent acrid resin, fixed oil, tannin, starch. Off. Prep.: Extractum Stillingiae Fluidum.

*Uses.*—In Compound Syrup Stillingia. Am. Disp. (Nat. Form.) The medicinal value of Stillingia is due chiefly to the oil; since this is insoluble in water the syrup is more or less cloudy. The Compound Fluid Extract should not yield a clear mixture with water, as in that case it must be nearly inert.

*Xanthoxylum.*—Xanthoxylum, U. S.—Prickly Ash. Bark of Xanthoxylum Americanum, Miller, and of X. Clava-Herculis, Linne. Nat. Ord., Rutaceæ. Constituents: Bitter principle, acrid oil, both acrid and tasteless resin, tannin. Off. Prep.: Extractum Xanthoxyli Fluidum.

#### SPECIES—TEA MIXTURES.

Mixtures of various drugs coarsely comminuted by slicing or bruising in an iron mortar, mixed often with aromatic drugs in their whole form, are called Species.

The following are mixtures of drugs, most of which are included in the foregoing groups:

*Breast Tea.*—Species Pectorales: Althæa, 8; Glycyrrhiza, Russian, peeled, 3; Orris, 1; Coltsfoot, 4; Mullein flowers, 2, and Anise (star), 2 parts. Contuse and mix.

*Laxative Tea.*—Species Laxantes: Senna, 16; Elder flowers, 10; Fennel, 5; Anise, 5, and Potassium Bitartrate, 4 parts. To the Senna (cut) add the potassium bitartrate, then the other ingredients, and mix the whole thoroughly.

*Wood Tea.*—Species Lignorum, "Blood-purifying Tea." Guaiac wood, 5;

Ononis (Rest-harrow root), 3; Glycyrrhiza, Russian, peeled, and Sassafras each, one part; mix.

*Fumigating Powder.*—A mixture of Lavender Rose Rosemary, Orris, etc., in various proportions, for incinerating in sick chambers etc.

UNOFFICIAL RESINOUS DRUGS—GROUP FOUR.

COM. NAME.	BOT. NAME.	PART USED.	CONSTITUENTS BESIDES RESIN.
Actæa.	Actæa spicata.	Root.	Acrid principle.
Aletris.	Aletris farinosa.	R'zome.	Bitter principle.
Apocynum (Dog's bane).	A. androsæmifolium.	R'zome & Root.	Bitter principle, etc.
Arbor Vitæ.	Thuya Occident.	Tops.	Vol. oil, tannin.
Arum (Indian Turnip).	Arisæma triphyllum	Corm.	Volatile acrid principle
Azedarach.	Melia A.	Root b'k.	Bitter resin.
Bela.	Aegle Marmelos.	Fruit.	Bit. prin., tan., vol oil
Canella.	(See Group 2).		
Cannabis Am	C. sativa.	Fl. h'b.	Resins, vol. oil.
Chelone.	Chelone glabra.	Herb.	Bitter principle.
Collinsonia.	C. Canadensis.	R'zome & root.	Bitter principle.
Coltsfoot.	Tussilago farfara.	Herb.	Bit. prin., tan., muc'lg.
Damiana.	Turnera microphylla.	Leaves.	Bit. prin., vol. oil, resin
Dioscorea.	Dioscorea villosa.	R'zome.	Acrid principle.
Dracontium	Symplocarpus foetidus.	R'zome.	Acrid principle.
Drosera (Sun dew)	D. rotundifolia.	Herb.	Acrid resin, etc.
Euphorbia	E. corollata.	Root.	Acrid resin, etc.
Feverfew.	Pyrethr. Parthenium.	Herb.	Bit. prin., vol. oil.
Gnaphalium.	G. polyccephalum.	Herb.	Bit. prin., vol. oil.
Helianthemum.	H. Canadense.	Herb.	Bit. principle, tannin
Heraclum.	H. lanatum.	Root l'ves fr'ts.	Acrid principle, vol oil.
Hypericum.	H. perforatum.	Herb.	Color, tannin.
Leonurus.	L. cardiaca.	Herb.	Bit. principle, vol. oil.
Liatis.	L. spicata and species.	Tuber.	Volatile oil.
Lycopus.	L. Virginicus.	Herb.	Bit. prin., vol. oil, tan
Menyanthis.	M. trifoliata.	Leaves.	Acrid prin., m'y'nthin
Milkweed.	Asclepias cornutti.	R'zome.	Bit. prin., asclepiion. tannin.
Myrica.	Myrica cerifera.	Bark.	Myricinic acid.
Nymphæa.	Nymphæa odorata.	R'zome.	Bit. prin., muc'lg., tan
Panax (Ginseng).	Panax quinquefolia.	Root.	Panaquilon.
Pimpernel	(See Group 3).		
Ricinus	Ricinus communis.	Seed.	Acrid prin., fixed oil
Sabbatia.	S. angularis and spec.	Herb.	Bit. prin., erythrocen-taurin.
Senecio (Life root)	Senecio aureus.	H'b & R't.	Bit. principle, tannin.
Silphium.	S. laciniatum and spec.	Root.	Resins, vol. oil
Trillium.	T. erectum and spec.	R'zome.	Acrid principle, etc
Triosteum	T. perfoliatum.	R'zome & Root.	Bitter principle, etc.
Turmeric.	(See Group 3)		
Viscum (Mistl'toe)	Viscum album	Herb.	Salts, and fixed oil.
Wintera.	(See Group 3 )		

## The Fixed Oils and Fats.

The Fatty Oils constitute a very distinct natural group of ternary compounds, and are found widely distributed in both the animal and vegetable kingdoms, few animals or plants being entirely destitute of them.

In the higher Animals they are mainly stored beneath the skin in the connective tissue, in the abdominal cavity about the Kidneys, etc. In Plants they often constitute a considerable portion of the weight of Seeds and Fruits, but they are found not infrequently stored in smaller quantities in other parts of the plant. In both kingdoms they serve mainly as reserve stores of Food.

They are either liquid, semi-liquid or solid at ordinary temperatures; greasy to the feel when sufficiently fluid, they are lighter than water, and do not mingle with it in any proportion, are, with two exceptions, but *slightly soluble* in Alcohol, while they are *freely soluble* in Ether, Chloroform, Carbon Disulphide, Benzin and the Volatile Oils; they are *not volatilizable without<sup>1</sup> chemical change* and leave a greasy stain upon paper when heated, but at a temperature varying between 260° and 315°C. they boil, giving off irritating vapors, and most of them, when treated with alkali, form *soaps*.

The fixed oils are all *combustible*, burning with a smoky flame. Some remain unchanged for a long time when exposed to the air, while others, especially those that contain mucilaginous or proteid impurities, undergo change and become rancid, while still others gradually harden, lose their unctuous feel, and become tough, flexible and varnish-like. These last are called *drying oils*.

Chemically considered, the fixed oils are mixtures, in various proportions, of two or more compounds. The most important of these are:

Olein, Stearin, Palmitin, Myristin and Laurin.

There are several modifications of Olein, also many others of minor importance such as Butyrin.

These are regarded as *ethereal salts*. For the most part they are compounds of Glycerin (a triatomic alcohol), with Acids of the *oleic* and *fatty acid* series, and, on saponification, yield Glycerin; but some of them, when saponified, yield, instead of glycerin, some of the higher or more complex monatomic alcohols. To this class belong the *waxes*.

## PREPARATION.

Animal fats are prepared from the tissues usually by heating them to their melting point or a little above, either alone or in the presence of water, and separating the fused fat from the tissue by straining.

The fixed oils from vegetable structures are usually separated from the containing tissues by *expression*; sometimes by *extraction* with a volatile solvent, such as Benzin or Carbon Disulphide.

The material is usually ground or crushed, and then pressed, either cold or between metallic surfaces heated to a temperature a little above that of the melting point of the oil. Sometimes, however, the oil is obtained by boiling the material in the presence of water, and separating the refuse solid matter by straining. The product obtained by this last process is generally inferior to that derived by pressure alone.

## ADULTERATIONS.

These are chiefly mixtures of the rarer and more expensive kind with common and cheaper ones, and on account of the resemblance in composition, the fraud is difficult to detect.

The principal means of detection are by the *odor* when warmed, and by their behavior to certain reagents, *color* reactions with acids, and such oxidizing agents as Silver Nitrate.

There are a few oils that are nearly odorless, but for the most part they have a more or less characteristic odor, which, by carefully comparing a sample of a suspected product with one of known purity, would enable one to detect the presence of impurities. As the fixed oils do not differ widely in their densities, the specific gravity test must be carefully applied.

The determination of the *boiling point* is also serviceable in some cases, particularly in determining whether or not there has been an admixture of volatile oils.

The presence of *fish oil* as an adulterant of any of the vegetable oils may readily be detected by passing a current of Chlorine gas through the oil. If it be pure, no change of color will take place, but if fish oil has been used as an adulterant, the mixture will turn dark.

Another test applicable in a few cases is the *sulphuric acid* test. If ten parts of the oil be heated with one of Sulphuric Acid, different colorations will be produced, which will depend upon the nature of the oil. For instance, Oil of Black Mustard will be changed to a *bluish green*, Linseed Oil will turn *brown*, and Fish Oil will assume a *reddish* color.

## PURIFICATION AND PRESERVATION.

As has already been stated the presence of mucilaginous and protein compounds in oils tends to produce rancidity; it is, therefore, desirable to get rid of these impurities.

This is done either by filtration or by the introduction of some reagent that destroys the impurities. When the quantity to be purified is small, the filtration process is generally resorted to. Care should be taken in this process that the filter be perfectly dry, or the water-bath filter may be used.

When the quantity is considerable, Sulphuric Acid is gradually added to the amount of from 1 to 2%. This carbonizes the impurities, and after separating the acid by repeated agitation with water, the carbonized impurities are gotten rid of by filtration.

As many fixed oils undergo gradual change, even if pure, when exposed to light and air, they should be kept in closed vessels; also, as these changes occur more rapidly at an elevated than at a low temperature, they should be kept in a cool place.

#### CLASSIFICATION.

The Fixed Oils may be classified as follows:

##### I. Those which yield glycerin—

###### (1) Liquid fats.

- a. Drying Oils: Flaxseed, Hemp, Nut and Poppy Oils.
- b. Non-Drying Oils: Olive, Almond, Colza, Rape and Lard, Tallow and Neatsfoot Oils.

Intermediate Oils partaking partly  
of the characters of both. } Fish Oils.  
} Cotton Seed Oil Group.  
} Castor Oil Group.

###### (2) Solid fats.

- a. The Non-Odorous: Lard, Suet and Wool-Fats.
- b. The Odorous: Nutmeg, Laurel, Palm, Cacao, Cocoanut Oils and Butter.

##### II. Those which yield no glycerin, the Waxes.

These Groups will be considered in their order.

#### LIQUID FATS.

Under Liquid Fats are included those which are liquid at *ordinary* temperatures, but many of these become solid or partly so at a *low* temperature. Usually by reducing the temperature one of the constituent oils solidifies before the other, and hence often by this means it may be separated.

#### THE DRYING OILS.

These are all derived from the vegetable kingdom and are distinguished from the other oils by the fact that by exposure to the air they are gradually converted into tough, flexible, varnish-like masses. They are *not solidified* by Nitrous Acid.

The most important members of the group are:

*Flaxseed Oil.* Oleum Lini, U. S.—Obtained by pressure from seeds of Linum usitatissimum without the use of heat.

Color, yellow, or if obtained by hot pressure, darker. Odor, slight. Taste, bland. Sp. gr. 0.930 to 0.940; does not congeal above  $-20^{\circ}\text{C}$ . Composed of palmitin, myristin and linolein, mainly.

*Uses.*—As demulcent; externally, as protective; mixed with Lime water as a dressing for burns, "Caron Oil."

*Off. Prep.*—Linimentum Calcis; Sapo Mollis.

*Oil of Hemp.*—Oleum Cannabis.—Obtained by pressure from crushed fruit of *Cannabis sativa*.

Color, green, changing to light brown on exposure. Odor, disagreeable. Taste, mild. Sp. gr. 0.930. Solidifies at about  $-15^{\circ}\text{C}$ . Composed of palmitin, linolein, and possibly other oils.

*Uses.*—As demulcent and protective.

*Nut Oil.*—Oleum Juglandis.—Obtained by pressure from the seeds of various species of *Juglans*.

Color, greenish or none. Odor, faint. Taste, bland, nut-like, Sp. gr. 0.92. Solidifies at about  $-18^{\circ}\text{C}$ . Contains probably linolein with other fixed oils.

*Uses.*—As a demulcent and protective.

*Poppy-Seed Oil.*—Oleum Papaveris.—Obtained by pressure from the crushed seeds of *Papaver somniferum*.

Color, light yellow. Odor, slight. Taste, bland. Sp. gr. 0.92. Solidifies at  $-18^{\circ}\text{C}$ . Contains linolein, palmitin, and probably other fixed oils.

*Uses.*—Protective, demulcent.

#### THE NON-DRYING OILS.

These oils do *not solidify* on exposure to the air. They are also characterized by the fact that they become *solidified* when treated with Nitrous Acid. As a group also they are *less* fluid than the drying oils.

They may be subdivided into two kinds: Those of *vegetable* and those of *animal* origin.

To the former belong the oils of:

Olive,	Almond,	Colza,
Mustard,	Rape,	Earth-nut.

And to the animal oils:

Neatsfoot,	Lard Oil, Tallow and Bone Oil
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The most important of the first kind are:

*Olive Oil.*—Oleum Olivæ, U. S.—Obtained from the fruit of *Olea Europaea*; the best quality, or *virgin* oil, by cold pressure of crushed, ripe fruit; a second quality, known as Malaga Oil, from the unripe fruit. By mixing the residue from the expression with hot water, and again expressing and also from decayed material, the inferior qualities of oil are obtained.

Color, yellow or greenish yellow. Odor, faint, agreeable. Taste, bland. Sp. gr. 0.918. Crystalline deposit at 10°C., and at 0°C. forms a whitish, granular mass. Contains chiefly olein, also small quantities of palmitin, cholesterin, arachin, and probably stearin.

Largely adulterated with Cotton seed and other cheap oils whose presence may be detected by the *solidification* with Mercuric Nitrate, or the *coloration* produced by heating with an alcoholic solution Silver Nitrate. For these tests see U. S. Ph.

*Uses.*—As lenitive, demulcent and in many Ointments and Plasters.

*Off. Prep.*—Emplastrum Plumbi; Unguentum Diachylon.

*Oil of Almond.*—Oleum Amygdalæ Expressum, U. S.—Obtained from the crushed seeds of *Prunus Amygdalus* var. *amara*, by powerful pressure, previous to their treatment for obtaining the Oil of Bitter almond. May also be obtained in same way from the seeds of the Sweet Almond.

Color, yellowish Odor, faint, nutty, Taste, bland. Sp. gr. 0.92. Solidifies at about —20°C. Contains olein and a little palmitin.

Oils expressed from peach and apricot kernels resemble almond oil, but when the latter is mixed with an equal bulk of Nitric Acid, sp. gr. 1.16, and heated to 65°C., it does not turn yellow or orange, while the oils from peach and apricot, treated in the same way, do.

*Uses.*—As lenitive and demulcent.

*Off. Prep.*—Unguentum Aquæ Rosæ.

The most important animal non-drying oils are:

*Lard Oil.*—Oleum Adipis, U. S.—Obtained from Lard, by exposing it to a low temperature and then subjecting it to great pressure.

Nearly odorless, colorless and tasteless. Sp. gr. 0.910; deposits crystals at 10°C.; at 0°C. forms a white semi-solid mass. Contains olein, with some stearin and palmitin.

*Off. Prep.*—Unguentum Hydrargyri Nitratis.

*Neatsfoot Oil.*—Oleum Bubulum.— Obtained by boiling with water the fatty tissue of neatsfeet and straining.

Little odor or taste. Sp. gr. 0.915. Solid fats begin to separate at 0°C. Contains olein and solid fatty bodies.

*Uses.*—Mostly externally.

#### INTERMEDIATE OILS.

Oils partaking partly of the characters of both Drying and Non-Drying Oils.

This is a miscellaneous group, comprising oils both of animal and vegetable origin, most of which *thicken* but do not solidify on exposure.

They agree in becoming more or less thickened, but in *not solidifying* when treated with Nitrous Acid.

They are divisible into three distinct sub-groups, as follows:

(1) The Fish Oils; (2) the Cotton-Seed Oil group; (3) the Castor Oil group.

The Fish Oils include:

Cod Oil, Cod Liver Oil, Hake Oil, Sperm Oil, Porpoise Oil, Shark Oil and various others.

For the most part they change their consistence but little on prolonged exposure to the air; they turn *brown* on exposure to Chlorine gas; are *reddened* by boiling with caustic Alkali; are but *little* thickened on treatment with Nitrous Acid, and have a more or less disagreeable *fishy* odor.

*Cod Liver Oil*.—*Oleum Morrhuae*, U. S.—Obtained by cold expression from the livers of *Gadus Morrhua* and other species of the same genus, and preserved from contact with the air.

Color, light yellow. Odor, fishy. Taste disagreeable. Sp. gr. 0.92. Should separate very little or no solid fat at 0°C. Contains olein, palmitin, stearin, and minute quantities of iodine, bromine, biliary compounds, etc.

*Uses*.—Alterative, demulcent, nutritive. The inferior oils are amber-colored or brownish, of a more disagreeable odor and taste, and they deposit crystalline matter at a temperature higher than 0°C.

The remaining oils of this group are of but little value in pharmacy; they are chiefly employed as lubricating media.

The Cotton-seed Oil group includes:

Cotton-seed Oil, Sesami Oil, Beech-nut Oil, Sunflower Oil and some others.

Their *viscosity* is considerably increased by exposure to the air; they are considerably *thickened* by the action of Nitrous Acid, and they are mostly bland to the taste, and nearly odorless.

*Cotton-Seed Oil*.—*Oleum Gossypii Seminis*, U. S.—Obtained by pressure from the crushed seeds of *Gossypium herbaceum*. The crude brownish oil is treated with boiling water, and afterward with a little alkali to bleach and purify it.

Color, yellowish. Odor, slight. Taste, sweetish, similar to that of almond oil. Sp. gr. 0.92 to 0.93. Solidifies at 0°C., or a little below. Contains olein, palmitin, and yellow coloring matter.

*Uses*.—As a demulcent.

*Off. Prep.*.—Linimentum Ammoniae; L. Camphorae.

*Benne Oil*.—*Oleum Sesami*, U. S.—Teel Oil.—Obtained by pressure from the crushed seeds of *Sesamum Indicum*.

Color, transparent, yellow. Odor, little or none. Taste, bland. Sp. gr. 0.92. Solidifies at about 5°C., or a little above. Contains olein, palmitin.

stearin, and myristin. Uses, as a demulcent. Test, turns red-brown when treated with a mixture of a cold nitric and sulphuric acids.

The remaining oils of this group, in common with other oils possessing similar properties, such as the oil of the Peanut, etc., are used for domestic and culinary purposes. Their employment in pharmacy, however, is comparatively rare.

The Castor Oil group include Castor Oil and Croton Oil.

They are somewhat denser and more *viscid* than the members of the sub-group, behave similar to them as regards exposure to the air and Nitrous Acid, but differ from all the other oils in being *soluble* in Alcohol, and in possessing strongly *purgative* properties.

*Castor Oil*.—*Oleum Ricini*, U. S.—Obtained from the dried and crushed seeds of *Ricinus communis*. That obtained by *cold* pressure is the best. It is purified by agitating with warm water, and decanting the oil.

Color, none. Odor, light. Taste, nauseous, slightly acrid. Sp. gr. 0.96. Thickens at 0° C. and at—18° C. congeals to a yellowish mass. Soluble in an equal weight of alcohol. Consists of ricinolein, palmitin, and an acrid principle.

*Croton Oil*.—*Oleum Tiglii*, U. S.—Obtained by pressure from the crushed seeds of *Croton Tiglium*. Sometimes also obtained by treating crushed seeds with carbon disulphide and evaporating the solvent.

Color, yellowish or brownish. Odor, slight, peculiar. Taste, very acrid. Sp. gr. 0.95. Soluble when fresh in about sixty parts of alcohol, but its solubility increases with age. Contains palmitin, stearin, laurin, myristin, various odorous oils, as glycerides of valerianic and butyric acids; and also tiglinic acid and crotonol.

*Uses*.—As an irritant, rubefacient and sometimes internally as a drastic purgative. In doses exceeding 2 minims it is poisonous.

## THE SOLID FATS.

Under these are included all those Fatty substances which remain solid at ordinary temperatures. Their consistence depends upon the relative proportion of the various constituents and they are hard or soft as they contain more or less of Stearin or Olein, besides the principles of intermediate consistence, palmitin, myristin, laurin, etc. Their melting points are more or less variable, and may, under certain conditions, be permanently altered. Some are of *vegetable* and others of *animal* origin and they may be divided into two groups, viz.: Vegetable and Animal Fats. The vegetable fats all contain either a volatile oil or some other odorous substance.

*Cacao Butter*.—Oleum Theobromatis, U. S.—Obtained by hot pressure from the seeds of Theobroma Cacao, deprived of their seed-coats and crushed. Derived as a by-product in the manufacture of Chocolate.

Color, yellowish, changing to white on exposure. Hard. Odor, aromatic. Taste, similar to chocolate. Sp. gr. 0.96. Melts at about 32°C. (90°F.). Contains olein, stearin, palmitin, arachin, and laurin.

*Uses*.—As a vehicle for Suppositories and Ointments. Demulcent.

*Cocoanut Oil*.—Oleum Cocos.—Obtained from the seeds of Cocos nucifera, by boiling them in water and applying hot pressure.

Color, white. Consistence of butter. Odor, peculiar. Taste, bland (but rapidly becomes rancid, when both odor and taste are disagreeable). Melting point from 22°C. to 28°C. Contains laurin, palmitin, stearin, myristin; also glycerides of caprinic, caprylic, and capronic acids.

*Expressed Oil of Nutmeg*.—Oleum Myristicæ Expressum.—Obtained by hot pressure from the seeds of Myristica fragrans and other species of the same genus.

Color, yellowish or whitish, mottled with orange-brown. Odor, aromatic. Taste, spicy. Sp. gr. 0.995. Melts at about 45°C. Soluble in four times its weight of strong alcohol. Contains, besides volatile oil, myristin, myristic acid, and coloring matter.

*Uses*.—Stimulant, carminative.

*Laurel Oil*.—Oleum Lauri.—Obtained by steeping the fruit of Laurus nobilis in hot water and subjecting it to hot pressure.

Color, greenish. Consistence, semi-solid, granular. Odor and taste, aromatic, spicy. Melts at about 40°C. Contains volatile oil, laurin and other fat substances.

*Uses*.—In Ointment, etc. Stimulant and nervine.

*Palm Oil*.—Oleum Palmæ.—Obtained by heating the fruit of Elais Guiniensis with hot water and then subjecting it to hot pressure.

Color, orange red, but bleached by exposure to light. Odor, pleasant. Taste,

bland. Melts at 27°C. Rapidly becomes rancid on exposure. Contains olein, palmitin, and a coloring principle.

*Uses.*—Mainly for soaps, sometimes as demulcent.

The principal solid Animal fats are:

*Lard.*—Adeps, U. S.—Obtained from the fatty tissues of the Hog, *Sus scrofa*, by heating them with water and straining.

Color, white. Consistence, soft. Taste, bland. Sp. gr. 0.938. Melts at 38° to 40°C. (100°F.) to a liquid.

*Uses.*—As a vehicle for Ointments and also in Cerates.

*Adeps Benzoinatus*, U. S.—Benzoinated Lard.—Prepared by digesting Lard with 2% of powdered Benzoin and straining. For use in hot weather, 5% of wax should be added.

*Suet.*—Sevum, U. S.—Obtained from the fatty tissues of the abdomen of the Sheep, *Ovis aries*, by heating (preferably in a water-bath) and straining.

Color, white. Consistence, hard. Taste, bland. Melts at about 45°C. Contains olein and palmitin, but chiefly stearin. That from the Ox is similar in its properties.

*Uses.*—In the preparation of Cerates.

*Wool-Fat, Hydrous.*—Adeps Lanæ Hydrosus, U. S.—Lanolin. The purified fat of the Wool of the Sheep, mixed with not more than 30% of water. The crude fat is purified and mixed with water, which it has the power to absorb, furnishing a mixture of ointment-like consistence.

Color, white. Consistence nearly hard. Melts at 40°C. Contains chiefly cholesterin, chemically an alcohol not yielding glycerin.

*Uses.*—As an ointment vehicle for endermic medication, that is, when systemic effect is desired.

*Butter.*—Butyrum.—Obtained by churning the cream of cow's Milk.

Color, yellow. Consistency, rather soft. Odor, pleasant, peculiar, but when rancid, disagreeable, owing to the presence of butyric acid. Taste, agreeable, bland. Melts at about 28°C. Contains olein, palmitin, stearin, small quantities of glycerides of butyric, caprylic, capronic and caprinic acids, and traces of an odorous principle.

*Uses.*—As a demulcent and sometimes in Ointments. For pharmaceutical uses should be fresh, unsalted, and free from casein.

### THE WAXES.

The second of the two principal divisions of the Fats consists of those which yield no glycerin, but instead a complex monatomic alcohol. They are called Waxes, and are solid at ordinary temperatures.

They include: Bees' wax, Spermaceti and Chinese. Brazil Myrtle and Palm and some other waxes.

The most important, pharmaceutically, are:

*Wax*.—*Cera Flava*, U. S.—Obtained by melting the Honeycomb in hot water, separating the liquids by decantation and collecting and straining the wax.

Color, yellow. Odor, somewhat aromatic, honey-like. Nearly tasteless. Melts at about  $64^{\circ}\text{C}$ . Sp. gr. 0.96. Contains cerin, myricin, aromatic and coloring matters.

*White Wax*.—*Cera Alba*, U. S.—Is prepared from the yellow by exposing it in thin layers for some time to moisture and light. Melts at  $65^{\circ}\text{C}$ .

Wax is often adulterated with tallow or paraffin. The former is detected by its lower sp. gr., and by the fact that the mixture is softer than pure wax. Paraffin is best detected by heating one part of the suspected wax with five of Sulphuric Acid to  $160^{\circ}\text{C}$ ., and diluting the mixture with distilled water. If paraffin be present it will separate out, since it is not affected by the acid, while the wax undergoes chemical change.

*Uses*.—In Cerates, Plasters and Ointments mainly.

*Spermaceti*.—*Cetaceum*, U. S.—Obtained from deposits in cavities in the head of the Sperm-Whale, *Physeter macrocephalus*.

Color, white, translucent. Consistence, hard, crystalline. Without odor or taste. Sp. gr. about 0.95°. Melts at  $50^{\circ}\text{C}$ . Composed chiefly of cetin.

*Uses*.—In Ointments and Cerates.

*Petroleum Ointment*.—*Petrolatum*, U. S.—Sometimes classed with the waxes because of it containing Paraffin; was treated of under Petrolatum.

### OILY DRUGS, GROUP V.

This Group includes a few Drugs whose chief value in pharmacy is due to a bland Fixed Oil they contain. The oil is usually associated with gum or mucilage as in the case of Almond and Flaxseed and these drugs have, therefore, been treated with the Mucilaginous Drugs of Group 1.

The only other official is:

*Lycopodium*.—*Lycopodium*, U. S.—Spores of *Lycopodium clavatum*, Linne, and other species of *Lycopodium*. Nat. Ord., Lycopodiaceæ. Constituents: Fixed oil 47 per cent.

*Uses*.—As a protective for raw and inflamed surfaces. Also as a "dusting powder" for pills.

*Lycopodium* is very combustible, burning with a fine rose-colored flame, and is largely used in pyrotechnics. It should be kept remote from light and fire.

To this Group belong the parts of plants whence are derived the Oils, viz., The fruits of Olive, Laurel and Palm; the seeds of the Cotton plant, Sesami, Sunflower, Poppy; the various "Nuts," Butternut, Peanut, Beech and Cocoanut; the seeds of Cacao, and those that furnish the Castor and Croton Oils.

# Derivatives of Fats.

## SOAPs.

When fats or oils are mixed with salifiable bases the principles which they contain, viz.: Olein, Palmitin and Stearin, etc., are decomposed into their respective acids, *oleic*, *palmitic* and *stearic* acids, which unite with the base forming *soap*.

Fats, being mostly compounds of Glycerin with one or more of these Acids, are split up, when boiled with the base, by the reaction into *salts* and *glycerin*. The Glycerin is set free and may be obtained as a by-product in soap-making.

Soaps, therefore, chemically considered are *salts*, and consist of *oleates*, *palmitates* and *stearates* of the respective bases, according to the proportion of the several principles in the fats.

Soaps may be divided into two classes:

- (1) Soluble soaps.
- (2) Insoluble soaps.

*Soluble Soaps* comprise those made with Soda and Potassa and are respectively termed *hard* and *soft* soap. The finest Soap is made from Olive Oil and is sold under the name of Castile Soap, which furnishes the base for the finely perfumed toilet Soaps. It is official under the title:

*Soap*.—Sapo, U. S.—White Castile Soap.—Prepared from Soda and Olive Oil.

When dried to a constant weight at a temperature of  $110^{\circ}\text{C}$ ., it should not lose more than 36% of its weight (water).

*Off. Prep.*.—Emplastrum Saponis; Linimentum Saponis.

*Soft Soap*.—Sapo mollis, U. S.—Sapo viridis, Green Soap, U. S. Ph., '80. Prepared by heating 40 Gm. Linseed Oil with 9 Gm. Potassa dissolved in 45 C.C. of Water and adding 4 C.C. Alcohol, until the mixture is completely soluble in boiling water.

*Off. Prep.*.—Linimentum Saponis Mollis.

## OLEATES.

*Insoluble Soaps* or *Oleates*, as they are also termed, are formed by combining the fat acid with an Earth or *metallic oxide*, i. e., Alumina; Lead; Zinc. Usually made from Castile Soap they are not pure *oleates* but mixtures of *oleates* and *palmitates*. They are either dry powders or of the consistence of cerates.

*Uses*.—In various skin affections.

They are produced by *double* decomposition between a Soluble Soap and a solution of the Salt in water. (See Nat. Form.).

The class of Official Oleates are chemical solutions of bases in Oleic Acid; the acid is in excess and they are therefore liquid or semi-liquid:

*Oleatum Hydrargyri*, U. S.—Made by dissolving 20 Gm. Yellow Mercuric Oxide in 80 Gm. Oleic Acid.

*Oleatum Veratrini*, U. S.—Two per cent Veratrine in Oleic Acid.

*Oleatum Zinci*, U. S.—Five per cent Zinc Oxide in Oleic Acid. Should not be confounded with the dry Oleate.

*Oleic Acid*.— $\text{HC}_{18}\text{H}_{33}\text{O}_2$ .—Acidum Oleicum, U. S.—A monobasic acid of the series of Acids contained in Fats and Oils.

By subjecting fats to cold and pressure it may be separated from the more solid stearic acid and through this is obtained as a by-product in the manufacture of stearin candles. It may also be produced from Soaps by saponifying Olive Oil or Almond Oil by boiling one of these with Lead Oxide and Water, as in the making of Lead Plaster.

The lead plaster, or Lead Oleate, is decomposed with Hydrochloric Acid, which sets the Oleic Acid free. The acid is then obtained by dissolving it in Benzin and evaporating the solvent. The crude product is exposed to a temperature of 4 C., when the pure acid is separated from the solid portion by pressure.

A yellowish liquid, sp. gr. 0.900; insoluble in water and freely soluble in alcohol and ether. It becomes semi-solid a few degrees above the freezing point and at a lower temperature congeals to a solid mass.

*Stearic Acid*.— $\text{HC}_{18}\text{H}_{33}\text{O}_2$ .—Acidum Stearicum, U. S.—One of the series of Fat Acids, combined with glycerin, constituting the principal portion of the solid animal Fats; also present in some vegetable fats. It is chiefly prepared from Tallow by separating the Stearin from Olein by expression and forming the latter into Soap with an Alkali, when the Stearic Acid is obtained by decomposing the stearate (soap) with an Acid, as in the preceding.

A hard, white, glossy solid; insoluble in water; soluble in 45 parts of alcohol readily in boiling alcohol and in ether. The pure acid melts at 69 C.; the commercial acid should have a melting point not lower than 56 C.

*Uses*.—In the preparation of Soaps; also in Suppositoria Glycerini, U. S.

*Glycerin*.— $\text{C}_3\text{H}_5(\text{OH})_3$ .—Glycerinum, U. S.—A liquid obtained by the decomposition of Animal or Vegetable Fats or Fixed Oils and containing not less than 95 per cent of absolute glycerin. Chemically it is a triatomic alcohol; propenyl, or glyceryl hydrate.

It is obtained as a by-product in the manufacture of Soap, and of Lead Plaster, or by subjecting Fats to a high temperature under pressure and in the presence of water, when they are decomposed into fatty acids and Glycerin, the latter passing into solution in the water.

A transparent, colorless, oily liquid, sweet and warm to the taste; sp. gr. not less than 1.25, which corresponds to 95% of absolute glycerin. Its boiling point is 165°C., but it does not vaporize unchanged, a portion of it being converted into acrolein and other empyreumatic products. It may, however, be distilled unchanged in a current of superheated steam, and advantage is taken of this fact in purifying it. It may be obtained, but with difficulty, in the crystalline form. It is soluble in all proportions in water and alcohol, in a mixture of 3 of alcohol and 1 of ether; miscible slightly with fixed and volatile oils; insoluble in ether, benzin, chloroform, etc.

Glycerin, like the other alcohols described, is combustible, and burns with a bluish, non-luminous flame. Like them also, there may be formed from it a series of Ethers and Aldehydes.

*Nitro-Glycerin* is regarded as one of its ethereal salts. It is formed by pouring Glycerin drop by drop into a mixture of Nitric and Sulphuric Acids in a vessel immersed in a freezing mixture. The resulting oily liquid is afterward purified by washing it in water. Taken internally, it is poisonous. Mixed with some inert material like infusorial earth, it constitutes dynamite.

*Uses.*—It is used medicinally under the name of *glonoin*, or *trinitrin* in the form of a one per cent alcoholic solution. (See *Spiritus Glonoini*, U. S. Ph.)

The pharmaceutical uses of glycerin are important; it is the vehicle for the official Glycerites, enters into the menstrua of several Fluid Extracts and Tinctures, is a constituent of the official tragacanth mucilage, and serves as a vehicle in many other preparations.

## The Tannins.

Tannic Acid or Tannin is a substance peculiar to, and widely distributed in many plants. It occurs in various modifications as *gallo-tannic acids* from Nut-gall, *quercitannic acid* from the Oak, *catechu* and *kramerotannic acid* from Catechu and Krameria respectively, *cinchotannic acid* from Cinchona and many others.

They are composed of Carbon, Hydrogen and Oxygen in different and various proportions; are usually amorphous and soluble in water, alcohol and glycerin; their solutions have weak *acid* reaction and they are precipitated by most of the Metallic Salts and the Alkaloids. Boiled with dilute acids they are split into glucose and phlobaphene and because of this property they have been regarded as glucosides.

They have the property of forming an insoluble compound with gelatin, hence their value in the process of tanning, the tannin producing with the gelatin of raw hide an impervious, flexible surface upon which the usefulness of leather depends. Applied to the skin or mucous surfaces of the human body a similar but milder action causes a contraction of the tissues, a property termed *astringent*. The therapeutic use of tannins, or drugs containing them called Astringent Drugs, depends upon this property; indicated in irritated or otherwise diseased mucous surfaces.

The tannins are characterized by producing marked *coloration* with Salts of Iron which may be either *green* or *blue-black*, and the different varieties may in fact be distinguished through these variations in color.

*Tannic Acid.*— $\text{HC}_{14}\text{H}_9\text{O}_9$ . — Acidum Tannicum, U. S.—Gallo-tannic Acid, the variety obtained from Nutgall; chemically Digallic Acid, as it is changed into gallic acid through chemical reaction induced by heat and moisture. Prepared from powdered Nutgall by maceration with Water and extraction with Ether.

A light yellowish, amorphous, coarse powder or in spongy masses, nearly odorless and of strongly astringent taste. Soluble in 1 part of water, in 0.6 part of alcohol, in 1 part of glycerin with heat, freely soluble in dilute alcohol, almost insoluble in absolute ether, benzol, benzin or chloroform. It produces a bluish-black color with ferric chloride and the addition of a little lime water to a one-per-cent solution of it produces a bluish-white flocculent precipitate becoming more copious and deeper blue, finally acquiring a pinkish tint, upon excess of the lime water (distinction from Gallic Acid).

It precipitates gelatin and the alkaloids, is incompatible with metallic salts and forms explosive compounds with Potassium Chlorate, etc.

In moist condition or in solution it must not be brought in contact with iron vessels or spatulas.

*Off. Prep.*—Collodium Stypticum; Glyceritum, Trochisci, Unguentum Acidi Tannici.

*Gallic Acid.*— $\text{HC}_7\text{H}_6\text{O}_5 + \text{H}_2\text{O}$ .—Acidum Gallicum, U. S.—Obtained by exposing powdered Nutgall for a considerable time to the action of moist warm Air, and extracting the mass with hot Water. The gallotannic acid having the nature of a glucoside is slowly changed into gallic acid through the fermentation which sets in at a slightly elevated temperature. The latter is extracted from the pasty mass by means of hot water, which deposits crystals of the acid on cooling. Care must be observed not to bring the crystals in contact with iron during the process, otherwise discoloration will take place.

Whitish or fawn-colored silky needles, which are without odor and have a slightly astringent taste, soluble in 100 parts of cold and three parts of boiling water, in 5 parts of alcohol, in 12 parts of glycerin and 40 parts of ether; very slightly soluble in chloroform, benzol or benzin. It produces a bluish-black precipitate with ferric salts.

It differs from tannic acid in not being precipitated by a solution of Gelatin except in the presence of gum, in not precipitating Alkaloids and in that it does not color solutions of pure ferrous salts.

The only preparation is: Unguentum Acidi Gallici, 10%, U. S. Ph., '80.

*Pyrogallol.*— $\text{C}_6\text{H}_3(\text{OH})_3$ .—Pyrogallol, U. S.—Acidum Pyrogallicum U. S. Ph., '80.—A triatomic Phenol obtained chiefly by the dry distillation of Gallic Acid. It should be kept in dark amber-colored bottles.

Light, white laminæ or needles, acquiring a gray tint on exposure to air and light, soluble in 1.7 parts of water, in 1 part of alcohol and in 1.2 parts of ether.

*Uses.*—Rarely in medicine; extremely poisonous. Chiefly in Photography

## Astringent Drugs, Group VI.

This group includes drugs that are used in medicine mainly for their astringent properties. These properties are chiefly due to the presence of tannic or gallic acid, or both.

The astringent principles are often associated with mucilage, and many of them are therefore both demulcent and astringent in their properties.

Some of the drugs referred to in this group as Wild Cherry are usually classed as astringent, but as they contain other active constituents not astringent it was deemed best to treat of them as indicated.

Of Hamamelis and Haematoxylon it may be said that the acids to which their astringency is due, differ quite considerably from the tannic and gallic acids.

In their extraction rather strongly alcoholic menstrua containing Glycerin have been found the most effective and to prevent precipitation in the preparations.

*Castanea*.—*Castanea*, U. S.—Chestnut. Leaves of *Castanea dentata*, Sudworth. Nat. Ord., Cupuliferae. Should be collected in autumn while still green. Constituents: Tannin nine per cent, mucilage, extractive and a little resin. Off. Prep.: Extractum Castaneæ Fluidum.

*Uses*.—Infusion, one ounce to the pint, as a remedy for whooping cough.

*Catechu*.—*Catechu*, U. S.—Extract obtained from wood of *Acacia Catechu*, Willd. Nat. Ord., Leguminosæ.

The principal constituents are:

*Catechutannic acid*, from 25 to 50 per cent, soluble in cold water, giving an olive brown coloration with ferric salts.

*Catechin*, from 15 to 30 per cent, soluble in ether and alcohol, but slightly in water; produces a green color with ferric salts. It yields *Pyrocatechin* upon dry distillation.

*Protocatechuic acid* is formed by the action of potassa upon catechu and similar resinous tannins.

*Uses*.—In Compound Powders and as a Dye-Stuff. Pale catechu or Gambir is mostly used as a dye.

*Off. Prep.*.—Tinctura Catechu comp.; Trochisci Catechu.

*Cherry, Wild*.—(See Group 7.)

*Geranium*.—*Geranium*, U. S.—Cranesbill. Rhizome of *Geranium maculatum*, Linne. Nat. Ord., Geraniaceæ Constituents: Tan-

nin fifteen per cent. Off. Prep.: Extractum Geranii Fluidum and an unofficial Infusion.

*Hæmatoxylon*.—Hæmatoxylon, U. S.—Logwood. Heartwood of Hæmatoxylon Campechianum, Linne. Nat. Ord., Leguminosæ. Constituents: Hæmatoxylin, tannin and resin. Off. Prep.: Extractum Hæmatoxyli.

*Uses*.—As an addition to astringent mixtures, but chiefly for dyeing and in the preparation of Inks.

*Kino*.—Kino, U. S.—Inspissated juice of Pterocarpus Marsupium, Roxburgh. Nat. Ord., Leguminosæ. Constituents: Kino-tannic acid, Kino-red and pectin. Off. Prep.: Tinctura Kino.

*Uses*.—The Tincture is liable to gelatinization, which is best prevented by the use of strong alcohol as a menstruum.

*Krameria*.—Krameria, U. S.—Rhatany.—Root of Krameria triandra, Ruiz and Pavon, and K. Ixina, Linne. Nat. Ord., Polygaleæ. Constituents: Kramerero-tannic acid about ten per cent, resembles catechin in imparting a green color to ferric salts and in forming pyrocatechin by dry distillation; and red coloring matter.

*Off. Prep.*.—Extractum Krameriae; Extractum Krameriae Fluidum; Tinctura Krameriae.

*Nutgall*.—Galla, U. S.—Excrescence on Quercus lusitanica, Lamarck, Nat. Ord., Cupuliferæ, caused by puncture and deposited ova of Cynips Gallæ tinctoriae, Olivier. Nat. Ord., Hymenoptera of the class Insecta. Constituents: Tannic acid about sixty per cent, and gallic acid two or three per cent.

*Off. Prep.*.—Tinctura Gallæ; Unguentum Gallæ.

*Uses*.—In the preparation of Tannic and Gallic acids and Inks.

*Hamamelis*.—(See Group 4.)

*Matico*.—(See Group 4.)

*White Oak*.—Quercus alba, U. S.—Bark of Quercus alba, Linne. Nat. Ord., Cupuliferæ. Constituents: Tannin or quercitannic acid six to eleven per cent, producing a blue-black coloration with ferric salts, but not identical with gallotannic acid; resin and coloring matter.

*Uses*.—Chiefly in tanning leather.

*Pomegranate*.—(See Group 7.)

*Rubus*.—Rubus, U. S.—Blackberry. Bark of root of Rubus villosus, Aiton. R. Canadensis, Linne, and R. trivialis, Michaux. Nat. Ord., Rosaceæ. Constituents: Tannin ten per cent.

*Off. Prep.*.—Extractum Rubi Fluidum, Syrupus Rubi.

*Uses.*—As Decoction and Infusion. From the fermented juice of the berry, Blackberry Wine and Brandy, useful in summer complaints.

*Rumex.*—Rumex, U. S.—Yellow dock. Root of *Rumex crispus*, Linne and other species of *Rumex*. Nat. Ord., *Polygonaceæ*. Constituents: Tannin, chrysophan, chrysophanic acid, mucilage. Off. Prep.: Extractum Rumaticis Fluidum.

*Uses.*—Decoction, one ounce to the pint, also in Compound Syrup of *Stillingia* and various preparations of the American Dispensatory.

#### UNOFFICIAL ASTRINGENT DRUGS—GROUP SIX.

COM. NAME.	BOT. NAME.	PART USED.	CONSTITUENTS.
Agrimony	<i>A. eupatoria.</i>	Herb.	Tannin 5%.
Alder.	<i>Alnus serrulata.</i>	Bark.	Tannin 4%.
Areca.	<i>A. catechu.</i>	Seed	Tannin 15%, fixed oil
Avens.	<i>Geum rivale.</i>	R'zome.	Tannin, bitter prin.
Bistort.	<i>Polygonum bistorta.</i>	R'zome.	Tannin, etc.
Comfrey	<i>Sympythium officinale.</i>	Root.	Mucilage, tannin.
Diospyros, (Per- simmon).	<i>D. Virginiana.</i>	Fruit and Bark.	Tannin, sugar, etc
Hepatica.	<i>H. triloba, H. acutiloba.</i>	Herb	Tannin, mucilage.
Heuchera, (Alumroot).	<i>H. Americana.</i>	Root	Tannin 20%.
Oenotheria, (Evening P'mrose)	<i>O. biennis.</i>	Herb	Tannin, mucilage.
Plantain	<i>Plantago lanceolata.</i> <i>Plan-</i> <i>tago major.</i>	Herb	Tannin, bitter prin
Prinos (Black Alder).	<i>P. verticillatus.</i>	Bark	Tann., resin, bit prin.
Pulmonaria.	<i>P. officinalis.</i>	Herb.	Tann., mucilage, resin.
Spiræa. (Hard- hack).	<i>S. tomentosa.</i>	Flor. tops	Tannin, bitter prin.
Statice.	<i>S. limonium var. <i>Caroli-</i></i> <i>nianum.</i>	Root.	Tannin, mucilage.
Sumach.	<i>Rhus glabra.</i>	Bark.	Tannin, resin.
Tormentil.	<i>Potentilla tormentilla,</i>	R'zome.	Tannin. kinovic acid.

## Glucosidal Drugs, Group VII.

This group includes drugs whose virtues depend largely or wholly on the presence of *glucosides* and *neutral Principles*, or on peculiar *organic Acids*.

Some drugs are included under this head whose active principles have not yet been isolated, when there is good reason to believe such active principles are present in the drug.

Among the drugs included in the Glucosidal Group are a few which possess very peculiar characteristics, and are classed by some authors as *reactionary drugs*.

These contain two or more complex principles, one being an albuminous *ferment*, coagulable and destroyed by heat, but rendered active in the presence of water; the other, a still more complex principle, possessing *glucosidal* or feebly *alkaloidal* properties, and decomposed by the action of the ferment, in the presence of *water*, into various compounds, frequently volatile, and quite active medicinally.

*Definition.*—The term *glucoside* is applied to those organic principles which are readily resolvable into *glucose* and another organic principle, either by the action of mineral Acids, of Alkalies, or of Ferments.

They are nearly all *ternary* compounds, that is, composed of Carbon, Hydrogen and Oxygen, while one is quaternary or *nitrogenized*, viz.: Amygdalin,  $C_{20}H_{27}NO_{11}$  and two are *sulphureted* or complex, viz.: Sinalbin,  $C_{30}H_{44}N_2S_2O_{16}$ , and Sinigrin,  $C_{10}H_{18}NS_2KO_{10}$ .

They possess either neutral or acid properties, and occasionally form salts or crystalline compounds; some few are soluble in water, but the greater number are nearly insoluble in water, though readily soluble in alcohol.

The English ending *in*, Latin *inum*, has been officially adopted to distinguish them from the alkaloids ending in *ine*, Latin *ina*.

Some of the peculiar Organic Acids found in drugs might be classed as Glucosides, and are so classed by some authorities, because they are separable into glucose and another organic principle, and they are treated of here in that connection. The Neutral Principles are also included in this group, because in the present state of our knowledge of the organic principles it is very difficult to distinguish between these exceedingly complex substances.

## THE NEUTRAL PRINCIPLES.

A number of solid crystalline substances obtained from plants are termed *neutral principles*, as they are either neutral or feebly acid and form salts, if at all, with alkalies.

They are composed of Carbon, Hydrogen and Oxygen, are mostly insoluble in water, freely soluble in alcohol and either insoluble or slightly soluble in ether or chloroform.

They differ from Glucosides in not being resolvable into *glucose* and are distinguished from the Alkaloids in that they are *not precipitated* by tannic acid, mercuric potassium iodide or other alkaloid reagents. They are sometimes called "Bitter principles" because the bitter taste of the Drugs that furnish them is chiefly due to their presence. Medicinally they are the most active constituents of their respective drugs and many of them produce toxic effects to such a degree that they are classed with the *poisons*.

The following are official:

*Aloin*.—*Aloinum*, U. S.—Obtained from several varieties of Aloes, chiefly Barbadoes Aloes, *barbaloin* and Socotra, or Zanzibar, *socaloin*. They differ more or less in chemical composition and physical properties according to the source from which derived. Prepared by extracting the Aloes with acidulated boiling water, concentration and crystallization from warm dilute Alcohol.

Minute acicular crystals, or crystalline powder of yellowish color, soluble in 60 parts of water, from 20 to 30 parts of alcohol, sparingly in ether.

*Uses*.—As an ingredient in Pills, dose from 0.05 to 0.1, usually in conjunction with other cathartics.

*Elaterin*.— $C_{39}H_{28}O_5$ .—*Elaterinum*, U. S.—Obtained from Elaterium, a substance deposited by the juice of the fruit of *Ecballium Elaterium*, Linne. Nat. Ord., Cucurbitaceæ.

Minute, white scales or prismatic crystals, sparingly soluble in ordinary solvents, but soluble in 2.4 parts of chloroform.

*Uses*.—In the official Trituration 10%, a more uniform and reliable preparation than the crude drug, the so-called Clutterbuck's elaterium. Dose of the Trituration 0.5 deg.

*Picrotoxin*.— $C_{30}H_{34}O_{13}$ .—*Picrotoxinum*, U. S.—Obtained from the seed of *Anamirta paniculata*, Colebrooke. Nat. Ord., Menispermaceæ—“*Coccus Indicus*.”

Colorless, shining prismatic crystals or crystalline powder, having an intense bitter taste, soluble in 240 parts of water, in 9 parts of alcohol; also soluble in the acids and alkalies, slightly soluble in ether or chloroform.

*Uses*.—In the form of pills or granules, dose 1 mg.

*Piperin*.— $C_{17}H_{19}NO_2$ .—*Piperinum*, U. S.—Obtained from Pepper and from other plants of the Nat. Ord.; Piperaceæ. Classed with the

**Alkaloids.** Prepared by extraction with Alcohol or Ether and separation from the Oleoresin.

Pale yellowish, prismatic crystals, of a peppery taste, insoluble in water, soluble in 30 parts of alcohol.

*Uses.*—As an addition to antiperiodics in pills.

**Salicin.**— $C_{13}H_{18}O_7$ .—Salicinum, U. S.—Obtained from several species of Salix and Populus (Nat. Ord., Salicaceæ,) by digestion with Lead Oxide and extraction with water and purified by filtration through charcoal.

White, silky needles or crystalline powder, soluble in 28 parts of water, in 30 parts of alcohol, almost insoluble in ether or chloroform. It is colored violet by ferric chloride and sulphuric acid dissolves it with a red color.

Salicin is a true *glucosid*, being decomposed by a ferment, such as emulsin or saliva into saligenin,  $C_7H_8O_2$  and glucose,  $C_6H_{12}O_6$ .

*Uses.*—As a remedy in Rheumatism in doses from 0.5 to 1.0.

**Santonin.**— $C_{15}H_{18}O_3$ .—Santoninum, U. S.—Obtained from Santonica, Levant Wormseed, by boiling with Milk of Lime and decomposing the Calcium Santoninate formed with Hydrochloric Acid. The Santonin is dissolved in hot Alcohol, filtered through charcoal and crystallized.

Colorless, flattened, prismatic crystals, odorless, nearly tasteless but developing a bitter taste, nearly insoluble in water, soluble in 40 parts alcohol, in 4 parts chloroform, in 140 parts of ether and soluble in caustic alkalies. It is not affected by exposure to the air but turns yellow exposed to light and must be kept in amber-colored vials, or in a dark place.

*Uses.*—In the official Troches, Trochisci Santonini, containing 3 cg. in each. Alkalies impair the effect of Santonin, hence the Sodium Santoninate and the Troches of this, of the U. S. Ph., '80, have been discarded. The dose for children should not exceed 1 dkg. and should be followed by a purgative.

**Chrysarobin.**—Chrysarobinum U. S.—A neutral principle, in its commercial, more or less impure form, extracted from Goa Powder, a substance found deposited in the wood of Andira Araroba. Unguentum Chrysarobini 5%.

A pale orange-yellow powder, darkening on exposure to the air, almost insoluble in water or alcohol, soluble in 150 parts boiling alcohol with a slight residue; readily soluble in boiling benzol and in solutions of alkalies

*Uses.*—Externally only in Skin diseases, Ringworm, etc.

## REACTIONARY DRUGS.

The following Reactionary Drugs are official:

*Bitter Almond*.—Amygdala amara, U. S.—Seed of Prunus Amygdalus var. amara, De Candolle. Nat. Ord., Rosaceæ. Constituents: Fixed oil about 45 per cent, amygdalin, emulsin, mucilage, sugar, etc. Off. Prep.: Syrupus Amygdale.

When bitter almonds are brought into contact with water, the ferment *emulsin* decomposes the glucoside *amygdalin* into Hydrocyanic Acid, Oil of Bitter Almond and sugar.

*Uses*.—Chiefly for preparing oil of bitter almond.

*Wild Cherry*.—Prunus Virginiana, U. S.—Bark of Prunus serotina, Erhart. Nat. Ord., Rosaceæ. Constituents: Bitter principle, tannin, amygdalin and emulsin. Off. Prep.: Extractum Pruni Virginianæ Fluidum; Infusum Pruni Virginianæ; Syrupus Pruni Virginianæ.

Wild cherry bark should be collected in the month of October, as it then yields the greatest proportion of Hydrocyanic Acid; the thick, corky layer frequently found on old bark should be removed. When treated with water Hydrocyanic Acid is produced by the action of the *emulsin* upon *amygdalin*, similarly to the reaction of these principles in bitter almonds. Since the power of the ferment is destroyed by heat and the products are volatile the extraction must be effected in the cold and the vessel should be of glass and tightly covered.

*Black Mustard*.—Sinapis Nigra, U. S.—Seed of Brassica nigra, Linne. Nat. Ord., Cruciferae. Constituents: Fixed oil 25 per cent, myrosin, sinigrin, giving rise to volatile oil. Off. Prep.: Charta Sinapis.

*Uses*.—In coarse powder, or ground, for the preparation of Cataplasm, mixed with cold water. Black mustard is more irritant than the White, and is therefore frequently mixed with the latter when used to produce blister. Mustard seed oil is obtained by expression between hot plates of iron.

*White Mustard*.—Sinapis Alba, U. S.—Seed of Brassica alba, Linne. Nat. Ord., Cruciferae. Constituents: Fixed oil 20 to 25 per cent; sinalbin and myrosin giving rise to volatile oil.

*Uses*.—Similar to those of Black Mustard.

Both black and white mustard contain a ferment *myrosin*, and each a glucoside termed respectively *sinigrin* and *sinalbin*. In the presence of water these substances are decomposed by the myrosin, forming volatile compounds, to which the acrid taste and irritant action of both kinds of mustards are due.

In Black Mustard the *Sinigrin* is by this reaction transformed into Sulphocyanide of Allyl or Volatile Oil of Mustard, an exceedingly irritating and, when taken internally, poisonous substance; some acid potassium sulphate and sugar are also formed.

In White Mustard the *Sinalbin*, also termed Sulphocyanide of Sinapin, is decomposed by the action of *myrosin*, in the presence of water, into Sulphate of Sinapin and Sulphocyanide of Acrinyl, a thick, non-volatile oil, possessing vesicating properties. The base of the other compound, Sinapin, is an alkaloid,

## GLUCOSIDAL DRUGS.

*Aloes.*—The inspissated juice of leaves of several species of Aloes. Nat. Ord., Liliacæ. Constituents: Aloin, resin, vol. oil (small quantity). Off. Prep.: Extractum Aloes Aquosum; Extractum Colocynthidis comp.; Pilulae Aloes; Pil. Aloes et Asafœtidæ; Pil. Aloes et Ferri; Pil. Aloes et Mastiches; Pil. Aloes et Myrrhæ; Pil. Rhei comp.; Tinctura Aloes; Tinct. Aloes et Myrrhæ; Tinctura Benzoini comp.

*Aloe Barbadensis*, U. S.—From *Aloe vera*, Linne.

*Aloe Socotrana*, U. S.—From *Aloe Perryi*, Baker.

*Aloe Purificata*, U. S.—Prepared from Socotrin Aloes by fusing it on a water-bath, keeping it in a liquid form by the addition of Alcohol, whilst straining it and evaporating it until hard and brittle.

Of the three different kinds of Aloes occurring in commerce, viz.: Barbadoes, Cape and Socotrin or Zanzibar. Socotrin aloes is regarded as containing the greatest proportion of active principle—aloin—and as being less harsh in its action than the other varieties.

*Uses.*—Chiefly as Purified Aloes. It yields a light golden-yellow powder, and is an ingredient in many unofficial pills, etc., and in Comp. Powder of Aloes and Canella, "Hiera Picra," formerly official, prepared as follows: Aloes, Soc., four parts; Canella, one part; both in fine powder and thoroughly mixed.

*Apocynum.*—*Apocynum*, U. S.—Canadian Hemp. Root of *Apocynum Cannabinum*, Linne. Nat. Ord., Apocynaceæ. Constituents: Apocynin, apocynein, tannin, bitter extractive. Off. Prep.: Extractum Apocyni Fluidum.

*Uses.*—In preparing Apocynin, a resinoid, the preparation of which has not been published.

*Araroba.*—*Goa Powder*.—Powder obtained from cavities in trunk of *Andira Araroba*, Aguiar. Nat. Ord., Leguminosæ. Constituents: Resin, gum, chrysarobin.

*Uses.*—As a source of Chrysarobin, of which it contains about eighty per cent. and in Ointments.

*Bryonia.*—*Bryonia*, U. S.—Bryony. Root of *Bryonia alba* and *B. dioica*, Linne. Nat. Ord., Cucurbitaceæ. Constituents: Bryonin (glucoside). Off. Prep.: Tinctura Bryoniæ.

*Uses.*—Chiefly as homœopathic Tincture. A Fluid Extract is made with alcohol of 85 per cent.

*Calendula.*—*Calendula*, U. S.—Marigold, the florets of *Calendula officinalis*, Linne. Nat. Ord., Compositæ. Constituents: Vol. oil (trace), calendulin, bitter principle. Off. Prep.: Tinctura Calendulæ.

*Uses.*—Chiefly as a substitute for Arnica in the form of Tincture and Infusion, as an application for sprains and bruises.

*Calumba*.—*Calumba*, U. S.—Columbo. Root of *Jateorrhiza palmaria*, Miers. Nat. Ord.; Menispermaceæ. Constituents: Columbin, berberine, columbic acid. Off. Prep.: Extractum Calumbæ Fluidum; Tinctura Calumbæ.

*Uses*.—As Infusion, and in powder associated with other tonics.

*Cascarilla*.—(See Group 3.)

*Caulophyllum*.—(See Group 4.)

*Cetraria*.—(See Group 1.)

*Dulcamara*.—*Dulcamara*, U. S.—Bitter-sweet. Young branches of *Solanum dulcamara*, Linne. Nat. Ord., Solanaceæ. Constituents: Resin, dulcamarin (glucoside), etc. Off. Prep.: Extractum Dulcamaræ Fluidum.

*Uses*.—As Infusion and Decoction.

*Capsicum*.—*Capsicum*, U. S.—Cayenne Pepper. Fruit of *Capsicum fastigiatum*, Blume. Nat. Ord., Solanaceæ. Constituents: Volatile oil, capsaicin, resin, etc. Off. Prep.: Extractum Capsici Fluidum; Oleoresina Capsici; Tinctura Capsici.

*Uses*.—Chiefly in the powdered form as a condiment; also as a rubefacient in Liniments and Plasters

*Chimaphila*—*Chimaphila*, U. S.—Pipsissewa. Leaves of *Chimaphila umbellata*, Nuttall. Nat. Ord., Ericaceæ. Constituents: Chimaphilin, arbutin, ericolin, ursin, tannin, etc. Off. Prep.: Extractum Chimaphilæ Fluidum.

*Uses*.—As Infusion and as an ingredient in Syrup Stillingia Comp. Am. Disp.

*Chirata*.—*Chirata*, U. S.—Entire plant of *Swertia Chirata*, Hamilton. Nat. Ord., Gentianeæ. Constituents: Chiratin (glucoside) and ophelic acid. Off. Prep.: Extractum Chiratæ Fluidum; Tinctura Chiratæ.

*Uses*.—Sometimes as Infusion, now seldom used, being superseded by gentian and other less costly bitters.

*Cloves*.—(See Group 3.)

*Colocynth*.—*Colocynthis*, U. S.—Fruit of *Citrullus Colocynthis*, Schrader. Nat. Ord., Cucurbitaceæ. Constituents: Colocynthin, resin, fixed oil, etc. Off. Prep.: Extractum Colocynthidis; Extractum Colocynthidis comp.

*Uses*.—Chiefly for the preparation of the Extract, and in powdered form in combination with less drastic purgatives. The fruit should be deprived of the seeds previous to use, because they contain a considerable quantity of fixed oil which is undesirable in the preparations. The percentage yield of extract varies considerably, but averages about 17 per cent.

*Cubeb*.—(See Group 3.)

*Convallaria*.—*Convallaria*, U. S.—Lily of the Valley, the Rootlets and Rhizome of *Convallaria majalis*, Linne. Nat. Ord., *Liliaceæ*. Constituents: Convallarin and convallamarin. Off. Prep.: Extractum *Convallariæ* Fluidum.

*Uses*.—As a substitute for *Digitalis* in heart diseases.

*Corn Silk*.—*Zea*, U. S.—Styles and Stigmas of *Zea Mays*, Linne, “Indian Corn.” Nat. Ord., *Gramineæ*. Constituents: Maizenic acid, tannin, resin, fixed oil and sugar. Off. Prep.: Extractum *Zeæ* Fluidum, made by the same process as Fl. Extract of *Triticum*.

*Uses*.—As Infusion or Decoction.

*Digitalis*.—*Digitalis*, U. S.—Foxglove. Leaves of *Digitalis purpurea*, Linne. Nat. Ord., *Scrophularineæ*. Constituents: Digitalin, digitoxin and resin. Off. Prep., Extractum *Digitalis*; Extractum *Digitalis* Fluidum; Infusum *Digitalis*; Tinctura *Digitalis*.

The so-called “Digitalin” of commerce is a mixture of the various active principles, and should not be confounded with the pure active principle, the *Digitaline*, which possesses much greater strength.

*Ergot*.—*Ergota*, U. S.—Ergot of Rye. Sclerotium of *Claviceps purpurea*, Tulasne. Nat. Ord., Pyrenomycetes of the class *Carposporæ*, a fungus replacing the grain of common Rye, *Secale cœreale*, Linne. Constituents: Sclerotic acid, scleromucin, sclererythrin, fixed oil, etc. Off. Prep.: Extractum *Ergotæ*; Extractum *Ergotæ* Fluidum; Vinum *Ergotæ*.

Ergot should be kept in a close vessel and protected against insects by adding to it a little chloroform. When over one year old Ergot should be rejected.

Some doubt yet exists as to what the medicinally valuable principles of Ergot really are. The fact is conceded, however, that whether they be glucosidal, alkaloidal, or both, or whether it owes its value to a peculiar acid, the desirable principles are more soluble in water than in alcohol, and that, therefore, preparations made with aqueous menstrua are preferable to those with alcoholic menstrua.

Ergot contains from twenty-five to thirty-five per cent of a non-drying fixed oil more soluble in strongly alcoholic menstrua than in those more aqueous, and since this oil is very undesirable, its presence in the preparations is best avoided through the use of diluted alcohol (or still weaker, 40 per cent) for exhausting the drug.

*Uses*.—“Ergotin,” a misnomer for extracts supposed to represent the medicinal value of the drug. They vary in composition according to the process employed in their preparation, and may contain the principles soluble in alcohol only (Wigger's); those soluble in weaker (seventy-five per cent) alcohol

(Bonjean's); or those soluble in twenty per cent alcohol, the fixed oil having been removed (Hallberg in Am. Jour. Pharm., 1882).

The official Extract prepared by evaporating the fluid extract to about one-fifth of its volume is a more reliable preparation than the two first mentioned, although objectionable, owing to the fixed oil it contains, when dispensed in Pills. The extract, freed from oil, is best adapted to the pill-form.

Powdered Ergot quickly becomes rancid and thus unfit for use, which may be prevented by depriving the Ergot of its fixed oil with ether or petroleum-benzin. (See Pulv. Ergotæ purificat., Ph. Ger., or National Dispensatory.)

*Euonymus*.—*Euonymus*, U. S.—Wahoo. Bark of the Root of *Euonymus atropurpureus*, Jacquin. Nat. Ord., Celastrineæ. Constituents: Eunonymin, resin, asparagin, etc. Off. Prep.: Extractum Eunonymi.

*Uses*.—Eunonymin, a resinoid prepared by precipitating the alcoholic tincture in water; it is unreliable, and the Extract may be substituted for it with advantage.

*Eupatorium*.—*Eupatorium*, U. S.—Boneset. Leaves and flowering tops of *Eupatorium perfoliatum*, Linne. Nat. Ord., Compositæ. Constituents: Eupatorin (glucoside), volatile oil, resin. Off. Prep.: Extractum Eupatorii Fluidum; and Infusion unofficial.

*Frangula*.—(See Group 4.)

*Guarana*.—(See Group 8.)

*Glycyrrhiza*.—*Glycyrrhiza*, U. S.—Licorice Root. Root of *Glycyrrhiza glabra*, Linne, and of the variety *glandulifera*, Regel et Herder. Nat. Ord., Leguminosæ. Constituents: Glycyrrhizin, glycyramarin, sugar, asparagin and resin. Off. Prep.: Extractum Glycyrrhizæ Fluidum; Extractum Glycyrrhizæ Purum; Glycyrrhizatum Ammoniatum, Pulvis Glycyrrhizæ comp.; Extractum Sarsaparillæ comp.; Syrupus Sarsaparillæ comp.; Tinctura Rhei dulcis.

*Uses*.—The pure Extract, prepared by exhausting the root with ammoniated water and evaporating to the consistence of a soft extract, is entirely soluble in water, and therefore superior to the commercial extract of licorice, in the preparation of Brown Mixture (*Mistura Glycyrrhizæ comp.*). It should be mixed with 10 per cent of Glycerin to preserve it. A Syrup and Elixir are also prepared from it. (See National Formulary.)

*Glycyrrhizatum Ammoniatum*—“Glycyrrhizin.” U. S.—Made by precipitating the Ammoniacal liquid extract from the Root with Sulphuric Acid and dissolving the precipitate, first carefully washed, in Ammonia Water, then evaporating by a gentle heat until of syrupy consistence, spreading upon plates of glass to dry, and finally obtained as scales.

*Extractum Glycyrrhizæ*, U. S.—The commercial extract or stick Licorice. Should contain not less than 60 per cent of matter soluble in water.

The commercial powdered Extract of Licorice contains a large proportion of starch and other inert matter as adulterants to retain it in the pulverulent form. The powdered root is also frequently adulterated or obtained from inferior specimens of the root.

*Uses.*—Licorice and its various preparations, owing to their peculiar sweet taste, are largely employed as adjuvants to nauseous mixtures and to disguise the taste of bitter medicines, as of Quinine. It is the most effective ingredient in Compound Elixir Taraxacum.

*Juglans.*—*Juglans*, U. S.—Butternut. The bark of root of *Juglans cinerea*, Linne. Nat. Ord., Juglandaceæ. (Should be collected in autumn or very early spring.) Constituents: Nucin, tannin, fixed oil and volatile oil (trace). Off. Prep.: Extractum Juglandis.

*Uses.*—Juglandin, a resinoid, prepared by the general formula for this class; the official Extract is a more reliable and efficient preparation.

*Kamala.*—(See Group 4.)

*Leptandra.*—*Leptranda*, U. S.—“Culver’s Root.” Rhizome and rootlets of *Veronica Virginica*, Linne. Nat. Ord., Scrophularineæ. Constituents: Leptandrin, resin, saponin, etc. Off. Prep.: Extractum Leptandriæ; Extractum Leptandriæ Fluidum.

*Uses.*—“Leptandrin,” a resinoid, prepared by precipitating the Alcoholic Tincture in water and drying the precipitated Resin. The remaining clear liquid is boiled and Sulphuric Acid added until it ceases to produce a precipitate, the clear liquid is rejected, the precipitate washed to free it from sulphuric acid, dried, mixed with the Resin previously obtained, and powdered. This preparation represents all the virtues of Leptandra.

*Quillaja.*—*Quillaja*, U. S.—Soap Bark. Bark of *Quillaja Saponaria*, Molina. Nat. Ord., Rosaceæ. Constituent: Saponin, a poisonous principle. Off. Prep.: Tinctura Quillajæ.

*Uses.*—As a Detergent in cleaning delicate fabrics. Sometimes used to impart the quality of frothing to Soda Water Syrups and also as an Emulsifying Agent, but its use for these purposes is of questionable advantage.

*Quassia.*—*Quassia*, U. S.—Wood of *Picraea excelsa*, Lindley. Nat. Ord., Simarubeæ. Constituents: Quassin, resin. Off. Prep.: Extractum Quassiæ; Extractum Quassiæ Fluidum; Tinctura Quassiæ.

*Uses.*—As an ingredient in Bitters, and as an Infusion, often in conjunction with other bitters.

*Phytolacca.*—(See Group 4.)

*Rhubarb.*—*Rheum*, U. S.—Root of *Rheum officinale*, Baillon. Nat. Ord., Polygonaceæ. Constituents: Chrysophan, chrysophanic acid, erythroretin, emodin, phæoretin, aporetin, tannin. Off. Prep.: Extractum Rhei; Extractum Rhei Fluidum; Pilulæ Rhei; Pilulæ Rhei compositæ; Pulvis Rhei compositus; Syrupus Rhei; Tinctura Rhei; Tinctura Rhei Aromatica; Tinctura Rhei Dulcis.

*Uses.*—In the powdered form obtained from choice specimens of the root; the powder of commerce being frequently prepared from decayed and otherwise inferior roots. When Rhubarb in small square pieces is subjected to a heat of about 120° C. (roasted), the principles upon which its cathartic action depends are modified or destroyed, so that it becomes astringent in its properties, "Torrefied Rhubarb."

*Rhus Toxicodendron.*—*Rhus Toxicodendron*, U. S.—Poison Ivy or Poison Oak. Fresh leaves of *Rhus radicans*, Linne. Nat. Ord., *Anacardieæ*. Constituents: Toxicodendric acid, tannin, etc.

*Uses.*—A Tincture, to be prepared from the fresh leaves, according to the formula for *Tincturæ Herbarum recentium*, U. S. Ph.; chiefly used in homœopathy.

*Rumex.*—(See Group 6.)

*Santonica.*—*Santonica*, U. S.—Levant Wormseed. Unexpanded flower heads of *Artemisia pauciflora*, Weber. Nat. Ord., *Compositæ*. Constituents: Santonin one and a half to two per cent, volatile oil one per cent.

*Uses.*—Wormseed, covered with sugar; and in Decoction or Infusion, as anthelmintic. Its active principle, Santonin, in the form of Troches, containing  $\frac{1}{2}$  grain in each, is more eligible and effective. The principal use of the drug is in the preparation of Santonin, many thousand pounds being produced annually.

*Sarsaparilla.*—*Sarsaparilla*, U. S.—Root of *Smilax officinalis*, Kunth; *S. medica*, Schlechtendal and Chamisso; *S. papyracea*, Duhamel and other species of *Smilax*. Nat. Ord., *Liliaceæ*. Constituents: Parillin, resin, etc. Off. Prep.: Decoctum *Sarsaparillæ* comp.; Extractum *Sarsaparillæ* Fluidum comp.; Syrupus *Sarsaparillæ* comp.

Four kinds of Sarsaparilla occur in commerce, viz.: Honduras, Rio Negro, Mexican and Jamaica. Of these, the Honduras variety is the best; the Jamaica is the only kind official in the Ph. Br.; by others the Mexican is regarded as superior. It is quite likely that Sarsaparilla, no matter what kind, possesses but little medicinal value, and is an ingredient of only secondary importance in many of the preparations that bear its name.

*Senega.*—*Senega*, U. S.—Root of *Polygala Senega*, Linne. Nat. Ord., *Polygaleæ*. Constituents: Senegin, polygalin, or polygalic acid, fixed oil. Off. Prep.: Extractum *Senegæ* Fluidum; Syrupus *Scillæ* comp.; Syrupus *Senegæ*.

*Senega* is an exceedingly active drug, and care should be used in dispensing it. Its quality of frothing in aqueous mixtures is owing to the polygalin, a substance similar to saponin.

*Uses.*—Infusion and as Extract, formerly official, or Abstract

*Senna.*—*Senna*, U. S.—Leaflets of *Cassia acutifolia*, Delile, and *C. Angustifolia*, Vahl. Nat. Ord., *Leguminosæ*. Constituents: Cathartic

acid, sennacrol (a bitter principle), sennit. Off. Prep.: *Confectio Sennæ; Extractum Sennæ Fluidum; Infusum Sennæ comp.; Pulvis Glycyrrhizæ comp.; Syrupus Sarsaparillæ comp.; Syrupus Sennæ.*

The Pharmacopœia recognizes as Senna the leaves from two species of *Cassia*, of which that from *C. acutifolia* is known in commerce as *Alexandria Senna*, and that from *C. angustifolia* as *India Senna*, two varieties of which are known, viz.: *Tinnevelly* and *East India* or *Bombay*.

*Alexandria Senna* is probably more active than the *India Sennas* (*Tinnevelly* and *Bombay*) but not presenting as fine an appearance as *Tinnevelly*, the latter is usually preferred.

*Uses.*—By treating Senna with strong alcohol the principles to which the griping qualities are due are extracted, without in the least impairing its cathartic properties, when the drug, after being dried, is easily exhausted with water or weak alcohol.

*Extractum Sennæ Fluid. Aquosa.*—The drug is extracted with boiling water, and 20 per cent alcohol added to the cold infusion, to precipitate resinous principles as in the formula for the official syrup. This process is more simple than the first mentioned, and is nearly equally effective. Senna leaves extracted with Alcohol and afterward dried, "deresinized," act as a mild purgative and desirable as an ingredient in *Species Laxantes*, Ph. Ger.; Nat. Form.

*Squili.*—*Scilla*, U. S.—Bulb of *Urginea maritima*, Baker. Nat. Ord., *Liliaceæ*, deprived of its outer scale, sliced and the central portion rejected. Constituents: *Scillipicrin*, *scillitoxin*, *scillin* and mucilage. Off. Prep.: *Acetum Scillæ; Syrupus Scillæ; Extractum Scillæ Fluidum; Syrupus Scillæ comp.; Tinctura Scillæ.*

*Uses.*—In the powdered form; obtained by drying the squill until crisp, and adding about ten per cent of Milk Sugar during the process of powdering to preserve the squills in a pulverulent condition.

*Strophanthus.*—*Strophanthus*, U. S.—The Seed of *Strophanthus hispidus*, De Candolle. Nat. Ord., *Apocynaceæ*. Constituents: *Strophanthin* and fixed oil. Off. Prep.: *Tinctura Strophanthi*, 5 per cent.

*Uses.*—As a substitute for *Digitalis*, as a diuretic; poisonous.

*Taraxacum.*—*Taraxacum*, U. S.—Dandelion. Root of *Taraxacum officinale*, Weber. Nat. Ord., *Compositæ*, gathered in autumn. Constituents: *Inulin*, *taraxacin*, *resin*, *sugar*, etc. Off. Prep.: *Extractum Taraxaci; Extractum Taraxaci Fluidum.*

*Uses.*—In various unofficial preparations; the Extract as excipient for Pills.

*Thuja.*—(See Group 4.)

*Uva Ursi.*—*Uva Ursi*, U. S.—Bearberry. Leaves of *Arctostaphylos Uva Ursi*, Sprengel. Nat. Ord., *Ericaceæ*. Constituents: *Tannin*, *arbutin*, *ericolin* and *urson*. Off. Prep.: *Extractum Uvæ Ursi; Extractum Uvæ-Ursi Fluidum.*

*Uses.*—In Decoction and Infusion, and associated with other diuretic medicines.

*Vanilla.*—(See Group 3.)

*Viburnum Opulus*, U. S.—Cramp Bark, and

*Viburnum Prunifolium*, U. S.—Black Haw.

The Barks of their respective plants. Nat. Ord., Caprifoliaceæ. Constituents: Bitter principle (viburnin), bitter resin, valerianic acid, tannin. Off. Prep.: Extractum Viburni Prunifolii Fluidum; Extractum Viburni Opuli Fluidum.

*Uses.*—Similar to those of Valerian, which it closely resembles. *Viburnum opulus* or "Cramp Bark" is frequently preferred to *V. prunifolium*, because supposed to be more active.

#### UNOFFICIAL GLUCOSIDAL DRUGS—GROUP SEVEN.

COM. NAME.	BOT. NAME.	PART USED.	CONSTITUENTS.
Agaric (white).	Boletus laricis.	Plant.	Larinic, resin, acids.
Ailanthus.	<i>A. glandulosa.</i>	Bark.	Alianthic acid, tannin.
Apocynum (Dog's bane).	<i>A. Androsæmifolium.</i>	R'zome.	Bitter prin., vol. oil.
Carduus Benedictus.	<i>Cnicus benedictus.</i>	Herb.	Cnicin, tannin, etc.
Chamælirium (False Unicorn).	<i>C. luteum</i>	R'zome.	Chamælirin.
Cornus (Dogwood).	<i>C. Florida.</i>	Rt Bk.	Cornin, tan., resin.
Corydalis (Turkey Corn).	<i>Dicentra Canadensis</i>	Tubers.	Corydalin, resin, fumaric acid.
Coto.	(Source unknown.)	Bark.	Cotoin, vol. oil, acid.
Epigæa (Gravel plant).	<i>E. repens.</i>	Herb.	Arbutin, ericolin, ursin, tannin.
Helenium (Sneezeweed).	<i>H. autumnale.</i>	Herb.	Glucoside, resin, tan.
Helleborus (Black).	<i>Helleborus niger</i>	R'zome.	Helleborin, helleborin, resin.
Hippocastanum (Horsechestnut).	<i>Æsculus hippocastaneum.</i>	Bark	Æsculin, fraxin, tan.
Imperatoria.	<i>I. Ostruthia.</i>	Root.	Imperatorin, vol. oil.
Kalmia.	<i>K. latifolia.</i>	Leaves	Arbutin, resin, tan.
Lactuca (Lettuce).	<i>L. virosa.</i>	Herb.	Lactucin, acid, lactucopicrorin.
Larch.	<i>L. Americana.</i>	Bark	Acid, resin, tan, vol. oil
Liriodendron	<i>L. tulipifera.</i>	Bark.	Liriodendrin, resin, tan
Pansy.	<i>Viola tricolor.</i>	Herb	Bitter prin., resin.
Piscidia.	<i>P. erythrina</i>	Bark.	Piscidin, resin, fix. oil.
Polygonatum.	<i>P. biflorum; gigant.</i>	R'zome.	Convall'in, aspa'gin, etc
Saponaria.	<i>S. officinalis.</i>	Root.	Saponin.
Salix (Willow).	<i>S. alba and spec.</i>	Bark.	Salicin, tannin.
Simaruba.	<i>S. officinalis.</i>	Bark.	Quassia, resin, vol. oil.
Tonka.	<i>Dipterix odorata</i>	Fruit.	Coumarin, fixed oil.
Ustilago (Corn smut).	<i>U. Maydis.</i>	Fung.	Acids, fixed oil.
Xanthium.	<i>X. spinosum; strumarium.</i>	Fruit.	Xanthostrumarin, resin



## The Alkaloids.

Drugs whose virtues depend partly or wholly on the presence of one or more alkaloids are called Alkaloidal Drugs.

*Definition.*—The Alkaloids, or, as they are sometimes termed, vegetable alkalies, are peculiar organic bases containing Nitrogen, in addition to Carbon, Hydrogen, and, with few exceptions, Oxygen. They are allied to Ammonia, and, when heated with alkalies, give off ammonia, by which they are distinguished from the glucosides and neutral principles. They form crystallizable salts with acids, and are, medicinally, the most powerful of all the organic principles.

The alkaloids are usually named after the *genus* name of the plant from which they are obtained, with the suffix of *ine* (Latin *ina*), thus distinguishing them from the neutral principles and glucosides, which terminate in *in* (Latin *inum*).

There are many exceptions, however, to this rule, as, for example: Morphine, named in honor of the god of sleep, *Morpheus*; when two or more alkaloids are obtained from the same plant, as in the alkaloids derived from the Cinchonas; when the same alkaloid occurs in several different plants, as Berberine, and when derived from the name that the plant was originally referred to as Sparteine (*Spartium Scoparium*) since changed to another name (*Cytisus Scoparius*).

*Origin.*—The alkaloids may be found in all parts of the plant, yet in the greater number they are contained in the seeds and fruits, and in the trees they occur in the bark. They are usually combined in the plant with one or more vegetable Acids, often peculiar to the plant, as *meconic acid* in Opium, but frequently, also, with tannic acid or some derivative, of it, as *kinic* or *kinovic acid* in Cinchona.

*Properties.*—They are crystalline solids, with a few exceptions, viz.: Coniine, Lobeline, Sparteine and Nicotine which are liquid, and do not contain oxygen, but these also form crystallizable salts with acids. They are all precipitated by the alkalies.

In *solubility* the alkaloids vary greatly; by far the greater portion are insoluble, or only sparingly soluble in Water. They are freely soluble in Alcohol, especially when hot; some also in Ether, Benzol, Carbon disulphide, and Ethereal Oils, others in Amylic Alcohol and with one exception, morphine, they are very soluble in Chloroform.

These liquids are variously used in their extraction, according to their solvent power. Their Salts on the other hand are soluble in water, some very freely so, also in alcohol, but most of them are *insoluble* in ether and chloroform.

#### PREPARATION.

The preparation of alkaloids consists usually in extracting the drug with Water acidulated with about two per cent Acid; with alkaloids difficultly soluble the stronger inorganic acids, *i. e.*, Hydrochloric or Sulphuric Acids, are used; with others more soluble the organic acids, Acetic, Citric and Tartaric, are employed in the extraction, and with still others, such as Morphine, the drug is exhausted with Water alone, which dissolves it quite readily, as it exists in natural combination in the opium. From the watery solution the Morphine is precipitated by an Alkali, such as caustic Lime or Ammonia, which neutralizes the meconic acid with which it is combined as meconate, thus liberating the morphine. The morphine is then obtained quite pure by dissolving it in boiling alcohol, filtering through Animal charcoal, and allowing it to crystallize.

The *Cinchona Alkaloids* are best extracted with water, acidulated with Hydrochloric Acid, which, being much stronger than the acids with which the alkaloids are combined in the bark, replaces them and forms soluble salts. The alkaloids are set free by a strong alkali; in this instance Calcium Hydrate (milk of lime) in excess, a portion neutralizing the acid, the remainder being insoluble precipitates, carrying the alkaloids with it. This precipitate is freed from the clear solution, which contains calcium chloride and some coloring matter, dried, powdered, and then extracted with hot Alcohol repeatedly, which dissolves only the alkaloids, providing the mixture is free from water, until completely deprived of bitter taste, or exhausted. The alcoholic solution, usually somewhat colored, is filtered through animal charcoal, when the alkaloids may be obtained quite pure by slow evaporation of the alcohol.

To produce salts, sulphates for example, the solution is rendered just perceptibly acid to litmus by the addition of dilute sulphuric acid, and allowed to crystallize. As the proportion of the various cinchona alkaloids varies greatly with the kind of bark operated upon, it is necessary to separate them; this is done sometimes at different stages of the crystallization, sometimes by solution in solvents, in which one of these is soluble, and others are insoluble.

With some drugs the water extracts so much inert matter, starch, etc., as to render the subsequent extraction of the alkaloids from the extract exceedingly difficult. In such cases, Alcohol is used for ex-

traction, but this also extracts other constituents usually present in alkaloidal drugs, such as resin and fat, and the extract, therefore, while more concentrated, still contains a considerable proportion of inert matter, which must be rejected before the alkaloid can be obtained pure.

This is accomplished by mixing the extract with water acidulated with an appropriate Acid, and thoroughly exhausting it by repeated washings with the latter. The alkaloidal base contained in the extract is formed into a salt by the acid, and is dissolved in the water, which contains acid in excess. The resinous and fatty constituents, however, are not soluble in water, and still less so in acidulated water, and these are therefore left behind. The alkaloids may now be precipitated by an Alkali and dissolved in hot Alcohol, the solution rendered as colorless as possible by filtration through animal charcoal, and the alkaloids obtained pure by crystallization.

Some of the alkaloids, owing to their complex constitution, are so delicate that they are split up into other substances when subjected to prolonged heat in evaporation, or treated with the stronger alkalies, as, for example, atropine, pilocarpine.

These are obtained from the acidulated aqueous solution, first rendered slightly alkaline, so as to set the alkaloid free, by agitation with Chloroform which takes up the alkaloid, and, after settling to the bottom of the mixture the chloroformic solution is separated and leaves the pure alkaloid upon evaporation.

#### GENERAL TESTS.

With chemical reagents the alkaloids behave similarly to ammonia; they are all precipitated by tannic acid, which, forming an insoluble compound, is given as an antidote in cases of poisoning. Owing to their difference in composition, the reactions vary considerably, and are often characterized by the color produced, but the following are general tests:

1. *Sulphuric or Nitric acid* imparts to many a reddish color.
2. *Phospho-molybdic acid* produces a yellow precipitate.
3. *Sodium phospho-tungstate* forms precipitates, insoluble in water, alcohol, ether, and in all the mineral acids, except phosphoric.

4. *Mercuric Potassium Iodide*, U. S.—Mayer's Solution, forms insoluble precipitates of a yellowish color in acidulated aqueous solutions (not alcoholic). It is used for the quantitative estimation of alkaloids. (See U. S. Ph., p. 486 and Nat. Disp.)

With *Platinic* and *Auric Chlorides*, the Alkaloid Chlorides form very insoluble, crystalline double salts similar in composition to the ammonium compounds with the chlorides of these metals.

Also with the *Chlorides* and *Iodides* of Mercury, Bismuth, Zinc and Cadmium the Alkaloids unite to form insoluble double compounds.

The Alkaloids and their salts may therefore be regarded as *incompatibili* with these substances and they should not be dispensed in conjunction with them.

# Cinchona.—Opium.—Nux Vomica.

The respective alkaloidal strengths of the two important drugs, Cinchona and Opium, are required by the U. S. Ph. to be within certain specified limits. This is also required of the most important *preparations* of Opium and in one (the Extract) it is fixed definitely. Of Nux Vomica the alkaloidal strength is not fixed by the U. S. Ph., but all the preparations are required to contain a specified amount of total alkaloids.

The method of limiting the alkaloidal strength of all alkaloidal drugs and their preparations, termed *standardization*, except in the three mentioned, has so far not been adopted in the U. S. Ph. In so far as the proposition is based upon the assumption that the medicinal value of these drugs is *entirely* dependent on their alkaloidal constituents, or that our knowledge concerning them is sufficient for their satisfactory determination, it is wholly unwarranted; on the other hand, that their *comparative* value is frequently ascertained through standardization and that the method is an excellent corroborative expedient in determining the value of these drugs and their preparations are indisputable facts.

## THE CINCHONA BARKS.

The Cinchona Barks are obtained from many different species of the genus Cinchona, and vary considerably in the proportion of alkaloids they contain, hence also in medicinal value.

The Pharmacopœia recognizes, by the term Cinchona, the Calisaya Bark, formerly official as Yellow Cinchona, and any bark of *C. officinalis*, or other species and their hybrids, containing not less than 5 per cent Alkaloids, at least half being Quinine.

The Red Bark is designated as Cinchona Rubra; the other kind, known as "Pale" or Loxa Bark, not being official unless containing the required amount of alkaloids.

Formerly Cinchona was derived exclusively from South America where it was indigenous to Bolivia and Peru (Peruvian Bark). During recent years Cinchona trees have been cultivated in the East Indies, notably in the Dutch possessions of Ceylon and Java. This has resulted in producing Cinchona barks yielding a far greater proportion of alkaloids than obtained from American Cinchonas and also in increasing the relative amount of the most valuable alkaloid, the Quinine.

The *assay* process consists in extracting the Cinchona with Alcohol and Chloroform, converting the alkaloids into sulphates, liberating the

alkaloidal bases and extraction with Chloroform, which yields the total alkaloids upon evaporation. The Quinine is separated from the other alkaloids through their comparative insolubility in Ether.

*Cinchona*.—Cinchona, U. S.—Calisaya Bark. Bark of Cinchona Calisaya, Weddell; *C. officinalis*, Linne. Nat. Ord., Rubiaceæ. Constituents: Kinic, kinovic and cinchotannic acids; quinine, quinidine, cinchonine, cinchonidine and quinamine. Off. Prep.: Extractum Cinchonæ; Extractum Cinchonæ Fluidum; Infusum Cinchonæ; Tinctura Cinchonæ.

Calisaya Bark contains the quinine in rather more than one-half the quantity of the total amount of alkaloids, the proportion of cinchonidine, and especially cinchonine, being quite small. While the U. S. Ph. directs that this bark should contain at least two and one-half per cent of quinine, good specimens contain from 4 to 8 per cent of it, and correspondingly less of the other inferior alkaloids. Calisaya is also the most desirable kind of the cinchonas pharmaceutically, because it contains less of the more or less inert and insoluble constituents, such as cinchonic red, etc., and the liquid preparations are therefore less liable to precipitate than those made from other kinds of bark.

*Red Cinchona*.—Cinchona Rubra, U. S. - Bark of Cinchona succirubra, Pavon. Nat. Ord., Rubiaceæ, containing not less than five per cent of its peculiar alkaloids. Constituents: Same as *C. Calisaya*. Off. Prep.: Tinctura Cinchonæ composita.

This Cinchona, also known as Red Peruvian Bark or simply "Red Bark," contains usually somewhat less quinine than the Calisaya, and a larger proportion of the other constituents, especially cinchonic red. It is nevertheless a more valuable tonic than the yellow kind, and for this reason is directed to be used in the Compound Tincture of Cinchona. Its liquid preparations, especially the Fluid Extract (unofficial), are exceedingly prone to precipitate, which is to a great extent avoided by the addition of glycerin to the menstrua, which serves to keep the cinchonic red in solution.

*Extractum Chine aquosum*, Ph. Ger. "Ext. Chinæ frigid. parat," an extract prepared by exhausting the coarsely powdered bark with successive portions of water, concentrating, filtering and evaporating to soft extract consistence.

Spurious, or false, barks are distinguished from the Cinchona barks by Grahe's test: When about 1 Gm. of the bark, in pieces, is heated in a test-tube, carmine-red vapors are given off which finally condense to a red colored, tarry liquid, if true Cinchona bark.

#### THE CINCHONA ALKALOIDS.

A great many alkaloids have been obtained from Cinchona but most of these are derivatives of one of the four principal ones. These may be divided into two groups according to their characteristics:

1. Quinine and Quinidine.
2. Cinchonine and Cinchonidine.

In solubilities they differ widely, especially as to their solubility in Water, the Quinine Hydrochlorate being very soluble, the *acid* Sulphate the most soluble of all, the *neutral* Sulphate the least soluble of the sulphates of any of the alkaloids. The bases and all their salts are fairly soluble in Alcohol, Cinchonine the least of any. In Ether, Quinine is moderately soluble, its Salts, except the Hydrobromate, almost insoluble; the other three bases and their salts are very sparingly soluble in Ether, the Cinchonine least of all and upon this the method of separating the Quinine from the other alkaloids, in the process for assay, is based.

Quinine and Quinidine form two series of salts, viz.: *Neutral* salts as the Sulphate and *acid* salts as the Bisulphate; the former being very sparingly soluble in Water; the latter much more soluble.

While the solubility of the Quinine base in Water is increased by Ammonia and decreased by Potassa and Soda, the base is precipitated from the solutions of its Salts by all these alkalies, as well as by the Alkaline Carbonates and Bicarbonates.

The acid solutions of the Salts of the Quinine Group, Quinine and Quinidine, give a *blue* Color, termed *fluorescence* (1 in 100,000) which is prevented by Chlorine, Bromine, Iodine and Ferrocyanides. They also afford two reactions through which they and their salts are more clearly distinguished from the alkaloids of the other group, Cinchonine and Cinchonidine, viz:

*Thalleioquin Test.*—To a solution of the Salt (1 in 2,500) is added one-fifth its volume of Chlorine Water and then Ammonia Water, drop by drop; an *Emerald-green* coloration is produced, becoming *blue* in Acid reaction and *violet* in excess. Also modified: Potass. Chlor. 0.02, HCl 4 drops, warmed, add water 5 C.C. and 0.01 Quin. Sulph. and 1 C.C. Ammon. Water.

*Herafathite.*—The formation of crystals of Iodo-sulphate of Quinine by reaction of: Quinine Sulph. 8.1 dissolved in Acetic Acid 192, Alcohol 40, add Sulphuric Acid 1 and Tr. Iodine 8 Gm. Upon cooling beautifully colored crystals separate.

The second group, Cinchonine and Cinchonidine, do not afford any fluorescence in dilute acid solutions; they do not produce the thalleio-quin reaction and their free bases crystallize water-free, while the Quinine bases crystallize with water, forming efflorescent hydrates.

The Groups differ in their behavior to Polarized light:

Quinine and Cinchonine are *levo*-gyrate.

Quinidine and Cinchonidine are *dextro*-gyrate.

The Tartrates of Quinine and Cinchonine are *sparingly* soluble in water.

The Tartrates of Quinidine and Cinchonidine are *easily* soluble in water.

To determine whether or not Quinine or its Salts are *contaminated*

with the other alkaloids, advantage is taken of the *solubility* of Quinine Sulphate in Ammonia Water, as compared with the *insolubility* of the other Alkaloidal Sulphates.

The method employed is a modification of *Kerner's Test* and is prescribed by the U. S. Ph. for Quinine and its most important Salts:

The Quinine (2 Gm.) is mixed with a certain amount (1 Gm.) of Ammonium Sulphate and 10 C.C. distilled Water, the mixture thoroughly dried (rendered neutral if necessary) and agitated with 20 C.C. of Water, allowed to macerate for half an hour at 15°C. and then filtered through glass-wool. Five C.C. of this filtrate, in a test-tube, gently mixed with 7 C.C. of official Ammonia Water, without shaking, should produce a clear liquid. The presence of 1 per cent or more of the other alkaloids would be indicated by the liquid assuming a whitish cloudiness.

CINCHONA ALKALOIDS AND SALTS.	FORMULA.	SOLUBILITIES.					
		Water 15°C Boil'g.	Alcohol. 15°C Boil'g.	Ether. U. S.	Chlo- form.	Gly- cerin.	
QUININA (Quinine) .....	C <sub>20</sub> H <sub>24</sub> N <sub>2</sub> O <sub>2</sub> + 3H <sub>2</sub> O .....	1670 760	6	2	23	5	200
Quininæ Sulphas .....	(C <sub>20</sub> H <sub>24</sub> N <sub>2</sub> O <sub>2</sub> ) <sub>2</sub> H <sub>2</sub> SO <sub>4</sub> +7H <sub>2</sub> O.	740 30	65	3	Insol.	680	40
Quininæ Bisulphas .....	C <sub>20</sub> H <sub>24</sub> N <sub>2</sub> O <sub>2</sub> H <sub>2</sub> SO <sub>4</sub> +7H <sub>2</sub> O.	10 Very.	32	Very.	"	Insol.	.....
Quininæ Hydrochloras.	C <sub>20</sub> H <sub>24</sub> N <sub>2</sub> O <sub>2</sub> HCl+2H <sub>2</sub> O.	34	1	3	"	.....	9 .....
Quininæ Hydrobromas.	C <sub>20</sub> H <sub>24</sub> N <sub>2</sub> O <sub>2</sub> HBr+H <sub>2</sub> O..	54	Very.	0.6	"	6	12 .....
Quininæ Valerianas ...	C <sub>20</sub> H <sub>24</sub> N <sub>2</sub> O <sub>2</sub> C <sub>5</sub> H <sub>10</sub> O <sub>2</sub> +H <sub>2</sub> O	100	40	5	1	.....	.....
QUINIDINÆ (C <sub>20</sub> H <sub>24</sub> N <sub>2</sub> O <sub>2</sub> ) <sub>2</sub>	.....	.....	.....	.....	.....	.....	.....
Sulphas .....	H <sub>2</sub> SO <sub>4</sub> +2H <sub>2</sub> O	100	7	8	Very.	almost insol.	14 .....
CINCHONINA (Cinchonine).	C <sub>19</sub> H <sub>22</sub> N <sub>2</sub> O .....	3760	3500	116	26.5	526	163 .....
Cinchoninae Sulphas .....	(C <sub>19</sub> H <sub>22</sub> N <sub>2</sub> O) <sub>2</sub> H <sub>2</sub> SO <sub>4</sub> +2H <sub>2</sub> O.	66	13.6	10	3.25	almost insol.	78 .....
CINCHONIDI- NÆ, Sulphas.,	(C <sub>19</sub> H <sub>22</sub> N <sub>2</sub> O) <sub>2</sub> H <sub>2</sub> SO <sub>4</sub> +3H <sub>2</sub> O.	70	1.42	66	8	"	1316 .....

Quinine sulphate, with 7 molecules of water of crystallization, contains 16.18 per cent of Water and upon exposure loses as much as 10 to 12 per cent of water; it should therefore be kept in tightly stoppered containers in not too dry a place.

*Uses.* Chiefly in the form of powder inclosed in capsules, cachets and pills, coated with sugar or gelatin. The capsules may easily be given the preference over coated pills and have the advantage of being prepared in the pharmacy. For pill mass the best *excipient* is Glucose or Glycerite of Starch. Dilute or Aromatic Sulphuric Acid acts dissolving upon the salt and forms a mass which becomes rapidly brittle and must be quickly formed into pills when used instead of other excipients.

## OPIUM.

*Opium.*—Opium, U. S.—Concrete, milky exudation obtained by incising the unripe capsules of *Papaver somniferum*, Linne. Nat. Ord., Papaveraceæ, yielding in its normal moist condition not less than nine per cent of crystallized Morphine. Constituents: Morphine, codeine, thebaine, narcotine, narceine, pseudomorphine, papaverine, and many other alkaloids; also meconic acid, thebolactic acid and meconin. Off. Prep.: Opii Pulvis.

Opium contains about ten per cent of moisture, in exceptional instances twenty or even thirty per cent, and from nine to fourteen per cent of morphine. Preparations of opium should therefore not be prepared from the crude drug, but from powdered opium, which should contain not less than thirteen nor more than fifteen per cent of morphine.

The process of assay consists in exhausting the Opium with water and precipitating the alkaloids with Ammonia Water; the crystals are carefully separated from the mother-liquid and washed with Ether and Alcohol until obtained in a pure state.

The processes for the assay of the Tincture and the Extract differ in no essential particular from the process applied to the crude opium.

*Powdered Opium.*—Opii Pulvis, U. S.—Powdered Opium containing not less than thirteen nor more than fifteen per cent of crystallized morphine. Prepared by drying the crude drug, first separated into smaller pieces, at a temperature not exceeding 85°C. (185°F.), until it ceases to lose weight, and then reduced to a very fine (No. 80) powder. It is then assayed for its morphine strength (see Opium Assay, U. S. Ph.), and, if necessary, mixed with other specimens of powdered opium, to bring the strength within the limits prescribed by the Pharmacopeia.

*Deodorized Opium.*—Opium Deodoratum, U. S.—Opium Denarcotisatum—U. S. Ph., '80. Prepared from powdered opium by macerating it successively with Ether, which extracts the principles to which opium is supposed to owe its disturbing qualities. After having been freed from the Ether, the opium is thoroughly triturated with sufficient Sugar of Milk to represent its original weight. It is therefore of the same morphine strength as the powdered opium.

This is essentially the process employed in the preparation of the Deodorized Tincture of Opium. Petroleum benzin may be substituted for ether, owing to its economy; although it does not extract narcotine, it removes the principles which are supposed to be objectionable quite as completely as the more high-priced solvent.

For adulterations and means for their detection, see the U. S. or Nat. Dispensaries. Opium or its preparations may be recognized by the *deep-red* coloration produced by one of its constituents, Meconic Acid, with Ferric Salts, which differs from that produced with acetic acid by not disappearing on the addition of dilute hydrochloric acid.

The Tinctures and Extract are officially directed to be prepared from powdered Opium (No. 8o.) A coarser (granulated) powder may answer equally well, provided that it is dry and uniform in strength.

The designation "aqueous," so much applied to opium preparations, should be abolished since there are no "strictly alcoholic" preparations of Opium.

The following Preparations of opium are official:

Acetum Opii; Vinum Opii;

Tincturæ: Opii; Opii Deodorata; Ipecac. et Opii; and

Pulvis Ipecac. et Opii; all 10 per cent.

Extractum Opii, triturated with Sugar of Milk so as to contain 18 per cent morphine; Emplastrum Opii (6 per cent Ext.)

Tinctura Opii Camphorata 0.4 per cent.

Pilulae Opii 6.5 cg. (ea.); Trochisci Glycyrrhizæ et Opii (5 mg. (ea.)

#### THE OPIUM ALKALOIDS.

Of the nineteen alkaloids that have been obtained from Opium, only two are official, viz.: Morphine and Codeine; a third, Apomorphine, being produced artificially from either of these.

Morphine, the first alkaloid discovered, crystallizes with one molecule of water,  $C_{17}H_{19}NO_3 + H_2O$ .

It is very sparingly soluble in Water, Ether or Alcohol except at the boiling temperature. Its salts are readily formed by saturating the respective dilute acids with the alkaloidal base and obtained in crystals by concentrating the solutions by evaporation at a moderate temperature. The salts are freely soluble in Water and, except the sulphate, also moderately soluble in Alcohol; they are all practically insoluble in Ether.

The alkaloid and its salts are precipitated by solutions of Potassa and of Soda, but the precipitate is dissolved in excess of the alkali, in which Morphine differs from other alkaloids. It forms a bright *red* color with Nitric Acid, but remains colorless or becomes slightly yellowish with Sulphuric Acid, if free from the other opium alkaloids (narcotine, papaverine, etc.), and upon the addition of a small crystal of Potassium Permanganate, it should acquire but a greenish, no violet or purple color (distinction from strychnine). The 1-percent solution of the sulphate produces a *blue* color with a few drops of solution of Ferric Chloride, which is destroyed by acids, alcohol, or by heating. Morphine solution is rendered cloudy by Tannic Acid but the whitish coloration (or precipitate) quickly disappears upon the addition of Acetic Acid.

Morphine is a powerful reducing agent, acting upon oxides and salts of Silver and Gold and acids of Iodine, liberating the Iodine, thus producing a *reddish* color in Hydriodic Acid; it acts similarly upon the acids of Titan, Wolfram, Tin and Vanadium and with:

*Froehde's Reagent* (a 1-per-cent solution of Sodium Molybdate in Sulphuric Acid) it produces a play of colors ranging from *violet* into *blue*, then from dirty *green* into *yellow* and finally into pale *red* or pink. This is the most sensitive test for morphine, the reaction occurring with  $\frac{1}{200}$  mg. of the alkaloid in most dilute solution.

By boiling with Acids and treating it with Alkalies, Morphine loses one molecule of water and becomes *Apomorphine*,  $C_{17}H_{17}NO_2$ , the Hydrochlorate of which is official; it has entirely different properties from morphine and is more powerful as a poison.

*Codeine* is separated from morphine in the mixed alkaloids, in the process of manufacture, by precipitation and is removed by solution in Ether in which it is very soluble. Codeine throws morphine out of solution, when added to solutions of morphine salts.

OPIUM, ALKALOIDS AND SALTS.	FORMULA.	SOLUBILITIES.				Dose.	
		Water.		Alcohol.	Ether,		
		15°C. 15°C.	Bol'g. C'Bl'g.	15°C.	U. S.		Gr.
MORPHINA (Morphine)....	$C_{17}H_{19}NO_3 +$ $H_2O \dots\dots\dots$	4.350	455	300	36	4,000	1cg.
Morphiræ Sulphas .....	$(C_{17}H_{19}NO_3)_2$ $H_2SO_4 + 5H_2O.$	21	0.75	702	144	Alm. insol.	0.01 to
Morphinae Hydrochloras.	$C_{17}H_{19}NO_3$ $HCl + 3H_2O$	24	0.5	62	31	"	3cg. 0.03
Morphinæ Acetas .....	$C_{17}H_{19}NO_3$ $C_2H_4O_2 + 3H_2O$	2.5	1.5	47.6	14	1,700	
Apomorphinæ Hydrochloras.	$C_{17}H_{17}NO_2$ $HCl$		De- comp.	45	De- c'm'p	hypo.	derm.
CÖDEINA (Codeine).....	$C_{18}H_{21}NO_3 +$ $H_2O \dots\dots\dots$	80	17	3	Very	13	1cg. 2cg. 6cg.

*Uses.*—Morphine in powder, or granules, containing from  $\frac{1}{2}$  cg. ( $\frac{1}{2}$  gr.) to 3 cg. ( $\frac{1}{2}$  gr.), the maximum dose. Hypodermically the dose is one-half as much, or even less. A solution formerly official (70) contained 1 grain to the fl. ounce of water; Magendie's solution contained 2 grains to the fl. dram. Great care must be exercised in distinguishing between these two solutions, as fatal consequences have resulted from their confusion. Solutions of morphine should specify the strength desired. It should never be administered to children, the least quantity having sometimes proved fatal.

For *antidote* the stomach should be evacuated as promptly as possible by Mustard infusion, Zinc or Copper Sulphate. Hot Decoction of Coffee with Brandy or Whisky, but without milk, and exercise; as physiological antidote, Belladonna, or Atropine, hypodermically, should be employed.

*Codeine* has been used as a substitute for morphine in double the dose.

*Apomorphine* is used only as an emetic, dose 1 cg., or subcutaneously in one-half the dose.

### NUX VOMICA.

*Nux Vomica*.—Nux Vomica, U.S.—Seed of *Strychnos Nux-vomica*, Linne. Nat. Ord., Loganiaceæ. Constituents: Strychnine one-half to one per cent, brucine, loganine, igasuric acid and fixed oil.

*Uses*.—Chiefly for the preparation of Strychnine, one of the most powerful poisons, used extensively by trappers for killing fur-bearing animals; also in the powdered form. *Nux vomica* is reduced to a powder only with great difficulty, owing to its flexible or horny character, and to the fact that it contains about five per cent of fixed oil. By subjecting the seeds to the action of live-steam, however, and subsequently drying them, the integuments become brittle, and they are then easily powdered.

All the Preparations of *Nux Vomica* are required to contain a definite percentage amount of *total Alkaloids*.

While strychnine is the most active, if not the only active, constituent, the U. S. Ph. does not fix the strychnine percentages but only the total alkaloid amount, because of the difficulties attending the separation of the strychnine from the other alkaloids. The strychnine constitutes usually about one-half of the total alkaloids.

Following are the official Preparations with their Alkaloidal strength and also their approximate Drug strength:

*Extractum Nucis Vomicæ*, contains 15% total alkaloids; yield from Drug about 10%; 1 of extract rep. 10 of Drug.

*Extractum Nucis Vomicæ Fluidum*, contains 1.5% total alkaloids; 1 C.C. rep. about 1 Gm. Drug.

*Tinctura Nucis Vomicæ*, contains 0.3% total alkaloids or 2% extract; 5 C.C. rep. about 1 Gm. of Drug.

In order to obtain the Extract in the powdered form it is necessary to free it from the fixed oil (derived from the Nux in the extraction) which constitutes nearly one-half of its weight. This is done by shaking it with Ether which dissolves out the oil, but also small quantities of the alkaloids; these are recovered from the oil, after evaporation of the ether, by washing with Water acidulated with Acetic Acid, rendering the liquid alkaline, extracting the alkaloid with Chloroform and adding it to the oil-free extract. After the Extract has been assayed it is triturated with sufficient Sugar of Milk (nearly an equal weight) to make it represent 15 per cent of total alkaloids.

From this Extract the tincture is made by solution in alcohol and water. The Fluid Extract is made by concentrating the percolate to one-fifth and, after assaying this extract, adding sufficient menstruum to make it represent one-tenth the strength of the Extract, or 1.5% total alkaloids.

The process of Assay for *Nux Vomica* is based upon the property of the Alkaloids to neutralize Acids. The operation of determining the quantity of alkali by saturating or neutralizing it with acids is that

branch of Analysis called *alkalimetry*. When performed by measure it is called Volumetric Analysis and the solutions employed *volumetric solutions* (V. S.). (See U. S. Ph., p. 482.)

A certain number of cubic centimeters of a *normal*, *decinormal* or *centinormal* solution of an acid, as Sulphuric Acid, is required to completely saturate a certain number of C.C. of similar solutions of *alkalies*, as Potassium Hydrate, or a certain quantity of the alkali. The point of exact *neutrality* is known by the effect on certain organic substances termed Indicators.

This process is adapted to the determination of alkaloids by obtaining these in a pure form in solution in a certain amount (C.C.) of decinormal Sulphuric Acid and then adding the required number of C.C. of centinormal Solution of Potassium Hydrate to effect saturation. The amount of alkaloid present is then found by reference and calculation from the tables.

For further information concerning Volumetric Analysis and its application to the assay of alkaloids refer to a "Hand-book of Pharmacy," by V. Coblenz, (N. Y.).

#### THE STRYCHNOS ALKALOIDS.

The plants of the Strychnos Family furnish several alkaloids distinguished as the most poisonous of the vegetable principles. The most important of these is *Strychnine*, obtained from the seed of *Strychnos Nux-vomica* and also from other plants of the Loganiaceæ, especially *Strychnos Ignatia*, formerly official. A second alkaloid, *Brucine*, is obtained as a by-product from the mother-liquid, where it is left in the preparation of strychnine, because of its greater solubility. The presence of a third alkaloid, *Loganine*, has not been established. The most powerful poison, "Curare," used for the purpose of poisoning arrows by Indians, and an alkaloid, *curarine*, are derived from allied plants.

*Strychnine* is almost insoluble in Water (6,700), but it is so intensely bitter that one grain is sufficient to impart a decided bitter taste to over 10 Gallons of Water; it is slightly soluble in Alcohol, insoluble in Ether, but very soluble in Chloroform, hence the use of this solvent in processes for the extraction of the alkaloids. Its salts, especially the sulphate, are moderately soluble in water and alcohol.

*Brucine* is much more soluble in Water and very soluble in Alcohol and Chloroform, but insoluble in Ether. It is poisonous but less so than *Strychnine*.

*Strychnine* is not colored by Sulphuric Acid, but when a little of it is dissolved in Sulphuric Acid and then a small crystal of Potassium Dichromate is drawn through the liquid with a glass-rod, there will be produced a series of variegated colors, at first *blue* to *purplish-blue*, then gradually to *violet*, *purplish-red* and *cherry-red* in rapid succes-

sion and finally into *orange* or *yellow*. This is the most characteristic test for strychnine.

STRYCHNOS, ALKALOIDS AND SALTS.	FORMULA.	SOLUBILITIES.					
		Water. 15° C.	Alcohol. Boil'g.	Alcohol. 15° C	Ether, U. S.	Chloro- form	
STRYCHNINA (Strychnine)...	C <sub>21</sub> H <sub>22</sub> N <sub>2</sub> O <sub>2</sub> .....	6,700	2,500	110	12	Insol.	7
Strychninæ	(C <sub>21</sub> H <sub>22</sub> N <sub>2</sub> O <sub>2</sub> ) <sub>2</sub> .....						
Sulphas .....	H <sub>2</sub> SO <sub>4</sub> +5H <sub>2</sub> O ..	50	2	100	8.5	"	.....
BRUCINE.....	C <sub>23</sub> H <sub>26</sub> N <sub>2</sub> O <sub>4</sub> ....	320	150	2	.....	"	7

Strychnine is colored *yellow* by Nitric Acid, whereby it is distinguished from Brucine, which is colored *blood-red* by Nitric Acid and also in a mixture of it and Sulphuric Acid. When Strychnine is boiled with Hydrochloric Acid the liquid turns *red* upon the addition of a trace of Nitric Acid. Ammonium Sulphhydrate added to the solution of Brucine in Nitric Acid renders the latter intense *violet*.

*Uses.*—In the form of trituration, tablets, granules and associated with other agents in elixirs, syrups, etc. Hall's solution contains 1 grain of strychnine to the fl. ounce of weak Acetic Acid (colored red). Another solution contains 4 grains to the fl. ounce of Alcohol (preferably alcohol 70%); the best form may be made metrically; 1 Gm. in 100 C.C. which is a saturated solution.

The dose is from 2 mg. ( $\frac{1}{30}$  gr.) gradually increased to 5 mg. ( $\frac{1}{2}$  gr.).

The Hypodermic solution is usually made from the sulphate, one-per-cent solution in Water (1 Gm. in 100 C.C.).

*Antidote.*—Prompt evacuation of the stomach by emetics, Mustard Infusion, etc. Physiological antagonists are: Apomorphine hypodermically 2 cg., Chloral and Chloroform. Afterward purging with Castor Oil, saline Cathartics, etc.

# Alkaloids and Salts.

## THE MYDRIATIC ALKALOIDS.

A number of plants belonging to the natural order Solanaceæ yield a class of alkaloids which exercise a peculiar effect of dilating the pupil of the eye. This effect is termed *mydriasis* and the agents producing it, *mydriatics*.

These alkaloids, of which Atropine is the type, comprise Hyoscyamine, Hyoscine and several others, which, although obtained from different plants, are so closely related as to be considered identical and have nearly the same chemical and physical properties.

*Atropine*, the most important of this class, is obtained chiefly from the leaves and root of *Atropa Belladonna*; *Hyoscyamine* is obtained from the leaves and seeds of *Hyoscyamus niger* and also from the seeds of *Datura Stramonium*, formerly called *daturine*; from *Duboisia myoporoides* (*duboisine*) and from the root of *Scopolia atropoides* and *S. Japonica*, the alkaloids of which are also called *scopolamine* and *scopolin*, and also as a by-product in the preparation of Atropine from Belladonna, in which it is retained in the mother-liquid because of its greater solubility in water and dilute alcohol. Recent researches indicate that these are all identical with Hyoscyamine and in fact that the two alkaloids may be obtained from any one of all the different plants here mentioned.

*Hyoscine* is an uncrystallizable alkaloid derived from the mother-liquid from the preparation of Hyoscyamine and Atropine, from which it is also produced, by converting it into a Hydrochlorate, precipitating it as a Gold double-chloride, decomposing this and dissolving in Ether and crystallizing it as Hydrochlorate.

As to solubilities, the official Salts of these alkaloids are all very soluble in Water and in Alcohol; they are all very slightly soluble in Ether and sparingly or very slightly soluble in Chloroform. The base, Atropine, is sparingly soluble in water, but freely soluble in alcohol, ether and chloroform.

Atropine is split by HCl, at 100 to 130° C., into Tropin,  $C_8H_{15}NO$  and Tropic Acid,  $C_6H_{10}O_3$ , the former by reagents is reduced to a number of derivative compounds.

These Alkaloids and their Salts all respond to practically the same reactions:

With Sulphuric Acid no coloration until warmed, then *brownish*; 1 mg. warmed with Sulphuric Acid and diluted with an equal volume of Water, develops *orange-flower odor* and by the addition of a crystal of Potassium Dichromate or Permanganate the odor is changed to that of *Bitter Almond*.

A grain of it sprinkled with fuming Nitric Acid leaves a *yellow* residue, which when dampened with alcoholic solution of Potassa produces an intense *violet* color (Vitali's test).

All these alkaloids and their salts produce precipitates with Mercuric-potassium Iodide, but *not* with Platinic Chloride, through which they are distinguished from most other alkaloids.

They all produce precipitates with Auric Chloride and through the appearance of this compound, crystallized from alcohol, the various bases may be distinguished from each other. (See U. S. Ph.)

MYDRIATIC ALKALOIDS AND SALTS.	FORMULA.	SOURCE.	SOLUBILITIES.			
			Water. 15 C.	Alcohol. 15°C.	Ether, U. S.	Chloro- form.
ATROPINA (Atropine) ...	C <sub>17</sub> H <sub>23</sub> NO <sub>3</sub> .....	Atropa	130	3	16	4
Atropinae	(C <sub>17</sub> H <sub>23</sub> NO <sub>3</sub> ) <sub>2</sub>	Belladon-				
Su'phas .....	H <sub>2</sub> SO <sub>4</sub> .....	na ....	0.4	6.2	2,270	604
HYOSCYAMI- NÆ, Sulphas..	(C <sub>17</sub> H <sub>23</sub> NO <sub>3</sub> ) <sub>2</sub>	R'ts, l'ves.				
Hyoscyaminæ	H <sub>2</sub> SO <sub>4</sub> .....	Hyoscyam- us, Stra- monium...	0.5	2.5	Sl'htly	Slightly
Hydrobromas.	C <sub>17</sub> H <sub>23</sub> NO <sub>3</sub> HBr ..		0.3	2	3.000	250
HYOSCINÆ	C <sub>17</sub> H <sub>21</sub> NO <sub>4</sub> HBr	Leaves &				
Hydrobromas.	+ <sub>3</sub> H <sub>2</sub> O .....	Seeds...	1.9	13	Sl'htly	Slightly

*Homatropine*.—C<sub>16</sub>H<sub>21</sub>NO<sub>3</sub>.—Oxytoluyl-tropein is produced by acting upon the Amygdalic Acid Salt of Atropine with Sulphuric Acid, precipitation with Alkalies, extraction with Chloroform and crystallizing into the Hydrochlorate.

It is said to act as quickly as atropine and to have the advantage in that the effects on the pupil (dilatation) is of but from 12 to 24 hours duration as against a period of 8 days for the effects of atropine to wear off.

*Uses*.—In ophthalmology in one-per-cent solution. Hypodermically in doses ranging from  $\frac{1}{4}$  mg. ( $\frac{1}{250}$  gr.) to 1 cg. ( $\frac{1}{6}$  gr.). Sometimes by the mouth in doses somewhat larger, in the form of granules, tablets, etc.

#### OTHER OFFICIAL ALKALOIDS.

*Caffeine*. — C<sub>8</sub>H<sub>10</sub>N<sub>4</sub>O<sub>2</sub>+H<sub>2</sub>O. — Caffeina, U. S.—Theine. An alkaloid obtained from "Tea," Thea Sinensis, Linne. Nat. Ord., Ternstroemiaceæ; from Coffea Arabica, Linne. Nat. Ord., Rubiaceæ; also from Guarana and some other plants.

Soluble in 80 parts of water, in 33 parts alcohol, in 555 parts ether, in 7 parts of chloroform, in 9.5 parts boiling water and very soluble in boiling alcohol.

It is a very feeble base and forms salts with difficulty. The official preparations of it are not true compounds, but simply mixtures with citric acid:

*Caffeina Citrata*, U. S.—Caffeine and Citric Acid equal parts, dissolved in water, evaporated to dryness and powdered. It forms a clear solution with 3

parts of water, but is precipitated upon further dilution until 25 parts of water is added when it remains clear.

*Caffeina Citrata Effervescent*, U. S.—Same as the preceding mixed with Sodium Bicarbonate and Tartaric Acid, made into a paste with Alcohol, rubbed through a coarse sieve, dried and obtained as a granular powder.

It contains 2% of Citrated Caffeine; from 2 to 5 Gm. dissolved in water taken as an effervescent draught.

*Cocaine Hydrochlorate*.— $C_{17}H_{21}NO_4HCl$ .—Cocainæ Hydrochloras, U. S.—Obtained from Erythroxylon Coca. Coca Leaves. Contains also two other alkaloids, ecgonine,  $C_9H_{15}NO_3$ , and benzoylecgonin, both of which are left in the mother-liquor from the preparation of cocaine. These are converted into cocaine by a synthetic process, which adds considerably to the yield and has also reduced the cost of the alkaloid.

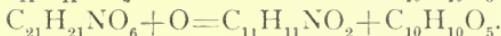
The hydrochlorate is the salt usually employed and is dispensed even when the alkaloid itself may inadvertently be prescribed.

It is soluble in about one-half its weight (0.48) of water, in 3.5 parts alcohol, in 2800 parts ether and in 17 parts of chloroform. Heated with Sulphuric Acid it gives off vapors of Benzoic Acid; at the ordinary temperature it is not colored by Sulphuric or Nitric Acids. It should be tested for the absence of other Coca bases by potassium permanganate. It may be distinguished by the sense of numbness it leaves upon the tongue.

*Uses*.—Chiefly in the form of solution from 1 to 5 per cent strength for hypodermic use. These should be prepared by metric quantities; 1 Gram for each per cent wanted, in 100 C.C. of Distilled or Chloroform Water. It should not be dispensed except upon prescriptions.

*Hydrastinine Hydrochlorate*.— $C_{11}H_{11}NO_2HCl$ .—Hydrastininæ Hydrochloras, U. S.—An artificial alkaloid derived from Hydrastine, the colorless alkaloid obtained from *Hydrastis Canadensis*.

Through oxidizing agents Hydrastine  $C_{21}H_{21}NO_6$  is converted into Hydrastinine,  $C_{11}H_{11}NO_2$  and Opianic Acid,  $C_{10}H_{10}O_5$ :



The hydrochlorate is in light yellow, amorphous granules or a pale yellow crystalline powder, very soluble in water and alcohol, difficultly soluble in ether or chloroform. It imparts a blue fluorescence to water, 1 mg. in 100 Liter.

*Uses*.—As an emmenagogue, as a substitute for Ergot, in doses of 2 to 3 cg.; or hypodermically in 10-per-cent solution.

*Physostigmine Sulphate*.— $(C_{15}H_{21}N_3O_2)_2H_2SO_4$ .—Physostigminæ Sulphas, U. S.—Eserine Sulphate. Obtained from *Physostigma*, “Calabar Bean.”

A yellowish white powder very deliquescent, gradually turning reddish upon exposure to the air and light and should therefore be kept in small, dark, amber-colored and well-stoppered vials. Very soluble in water and alcohol.

*Physostigmine Salicylate*.— $C_{15}H_{21}N_3O_2C_7H_6O_3$ .—Physostigminæ Salicylas, U. S.—Eserine Salicylate.

Faintly yellowish, acicular crystals, acquiring a reddish tint upon exposure and must therefore be kept with same precautions as the sulphate. Soluble in 150 parts of water, in 30 parts boiling water and in 12 parts of alcohol. Its aqueous solution produces with ferric chloride a deep violet color.

*Uses*.—As a motor depressant in doses of 1 mg. ( $\frac{1}{60}$  grain). Also in ophthalmology to contract the pupil in gelatin disks, Lamellæ, Ph. Br., containing  $\frac{1}{1000}$  grain.

*Pilocarpine Hydrochlorate*.— $C_{11}H_{16}N_2O_2HCl$ .—Pilocarpinæ Hydrochloras, U. S.—Obtained from Pilocarpus, or Jaborandi.

Small white crystals, deliquescent on exposure to damp air and should therefore be kept in small well-stoppered vials. Very soluble in water and alcohol; almost insoluble in ether or chloroform.

*Uses*.—A motor depressant, diaphoretic and sialagogue, 1 to 3 cg; hypodermically 1 cg.

*Sparteine Sulphate*.— $C_{15}H_{26}N_2H_2SO_4 + 4H_2O$ .—Sparteinæ Sulphas, U. S.—The neutral Sulphate of an alkaloid obtained from Scoparius, Cytisus (Sparteum) Scoparius.

White, prismatic crystals or granular powder, deliquescent when exposed to damp air. Very soluble in water and alcohol.

*Uses*.—A motor excitant, diuretic, laxative, in large doses emetic; dose 1 to 5 cg., hypodermically  $\frac{1}{2}$  to 3 cg.

*Veratrine*.—Veratrina, U. S.—A mixture of Alkaloids obtained from Cevadilla seed, Asagrea officinalis, and not from Veratrum as its name would indicate.

To the alkaloids obtained from Sabadilla and Veratrum (White Hellebore), the name was first applied, but when the distinction of the alkaloids of the two drugs had been proved, the name of *veratrine* was retained for the total alkaloids derived from Cevadilla, while those found in Veratrum were termed *jervine*, *veratralbine*, etc.

Veratrine is very slightly soluble in Water, soluble in 3 parts Alcohol, in 6 parts of Ether and in 2 parts Chloroform.

With Nitric Acid it forms a *yellow* solution; with Hydrochloric Acid upon heating a *deep-red* color.

With Sulphuric Acid, upon trituration in a glass-mortar, it forms a *yellow* or *orange-red* solution, exhibiting by reflected light a *greenish* fluorescence, while *deep-red* by transmitted light.

*Uses*.—Only externally in the form of the Oleate (2%), Ointment (4%). It produces great irritation in contact with the nasal membrane and, therefore, when employed in preparing Ointments, etc., should not be triturated in its dry form, but with the addition of a liquid substance. It is very poisonous.

# The Alkaloidal Drugs.

## UNOFFICIAL ALKALOIDS AND SALTS.

NAME OF ALKALOID.	FORMULA.	SOURCE.	SOLUBILITIES*.			Dose.
			Water	Alco.	Ether.	
Aconitine (Cryst.).....	$C_{33}H_{43}NO_{12}$ ....	Aconitum.....	726	24	40	mg $\frac{1}{2}$ $\frac{1}{2}\frac{1}{2}$
Aspidospermine	$C_{22}H_{30}N_2O_2$ ....	Aspidosp'ma.	6000	50	100	deg. 1 $\frac{1}{2}$ -2
Berberine hydrochlor.....	$C_{20}H_{17}NO_4$ $HCl + 4H_2O$	Berberis, Hydrastis.	Mod.	Mod.	" 1-3	$1\frac{1}{2}$ -3
Colchicine.....	$C_{20}H_{25}NO_6$ ....	Colchicum ...	"	Insol.	mg. 1	$\frac{1}{64}$
Coniine hydrobrom.....	$C_8H_{17}N.HBr$	Conium.....	"	"	cg. 1	$\frac{1}{6}$
Delphinine.....	$C_{22}H_{35}NO_6$ ....	Staphisagria.	Insol.	20	10	....
Emetine.....	Not determin'd	Ipecac .....	1000	Freely	Freely	cg. 1 $\frac{1}{6}$
Gelsemine .....	$C_{12}H_{14}NO_2$ ....	Gelsemium... Sp'g'ly	"	"	"	....
Hydrastine .....	$C_{21}H_{21}NO_6$ ....	Hydrastis .....	"	"	"	1-4 2-6
Jervine .....	$C_{26}H_{37}NO_3 +$ $2H_2O$ .....	Veratrum	alb. et vir.	Mod.	Spar.	....
Pelletierine (Punicine) tannate.....	$C_8H_{15}NO +$ $C_{14}H_9O_9$ ....	Granatum ...				0.4 7

\*The alkaloids are all soluble in chloroform.

*Aconite*.—Aconitum, U. S.—Aconite Root.—The tuberous Root of Aconitum Napellus, Linne. Nat. Ord., Ranunculaceæ. Constituents: Aconitine, napelline, fixed oil, etc. Off. Prep.: Extractum Aconiti; Extractum Aconiti Fluidum; Tinctura Aconiti.

Preparations of Aconite Leaves were formerly official (U. S. Ph., '70) and the Tincture and Extract are still occasionally employed. These are not as strong as the respective preparations of the root, and care should be taken that they be not confused with one another. Aconite is the most *poisonous* of the official Drugs.

*Uses*.—In preparing Aconitia, a mixture of the active principles not to be confounded with the crystallized alkaloid, Aconitine, Duquesnel; an Abstract and a Liniment, all formerly official.

*Aspidosperma*.—Aspidosperma, U. S.—Quebracho. Bark of Aspidosperma Quebracho-blanco, Schlechtal. Nat. Ord., Apocynaceæ. Constituents: "Aspidospermin," a mixture of several alkaloids: aspidospermine, aspidospermatine, quebrachine and two others; also tannin in considerable quantity. Off. Prep.: Extractum Aspidospermatis Fluidum.

*Belladonna Root*.—Belladonnæ Radix, U. S.—Root of Atropa Belladonna, Linne. Nat. Ord., Solanaceæ. Constituents: Atropine from 0.4 to 1 per cent and secondary alkaloids said to be identical with those obtained from *Hyoscyamus* and *Stramonium*. Off. Prep., Extractum Belladonnæ Radicis Fluidum.

*Uses*.—In the preparation of Atropine and in the form of powder; the Extract formerly in Belladonna Plaster and in the Abstract, '80. Old and woody roots should be rejected, as their yield of alkaloid is much less than in young, plump and light colored specimens of the drug.

*Belladonna Leaves*.—Belladonnæ Folia, U. S.—Leaves of Atropa Belladonna, Linne. Nat. Ord., Solanaceæ. Constituents: Same as in the Root in about the same proportion. Off. Prep.: Extractum Belladonnæ Foliorum Alcoholicum; Tinctura Belladonnæ Foliorum.

*Uses*.—Similar to the root; also in the "Powdered Extract" and in the official Belladonna Plaster.

*Calumba*.—(See Group 7.)

*Chelidonium*.—Chelidonium, U. S.—Celandine. Herb of Chelidonium majus, Linne. Nat. Ord., Papaveraceæ. Constituents: Chelidoneine, sanguinarine, chelidoxanthine, chelidonic acid.

*Uses*.—As Fluid Extract, Tincture and Extract Ph. Ger., prepared from the juice expressed from the fresh leaves.

*Colchicum Root*.—Colchici Radix, U. S.—Corm of Colchicum autumnale, Linne. Nat. Ord., Liliaceæ. Constituents: Colchicine, starch, etc. Off. Prep.: Extractum Colchici Radicis; Extractum Colchici Radicis Fluidum; Vinum Colchici Radicis.

*Uses*.—In the form of powder and in the preparation of an unofficial Vinegar and Oxymel.

*Colchicum Seed*.—Colchici Semen, U. S.—Seed of Colchicum autumnale, Linne. Nat. Ord., Liliaceæ. Constituents: Colchicine, colchiceine, fixed oil. Off. Prep.: Extractum Colchici Seminis Fluidum; Tinctura Colchici Seminis; Vinum Colchici Seminis.

Colchicum Seed contains a large proportion of fixed oil which is liable to separate and cause turbidity in its preparations; its uses are similar to those of the root.

*Conium*.—Conium, U. S.—Poison Hemlock. Fruit of Conium maculatum, Linne. Nat. Ord., Umbelliferae. Constituents: Coniine, conhydrine, fixed oil, volatile oil. Off. Prep.: Extractum Conii, Extractum Conii Fluidum, a Tincture and an Abstract formerly official.

The alkaloid Coniine is very volatile, and Acetic Acid is used in extracting the drug to "fix" it, that is to prevent its volatilization in the process of con-

centration which should be effected by a moderately warm heat. The leaves, formerly official, have been discarded, owing to their being often inert.

*Coca*.—Coca, U. S.—Erythroxylon, U. S. '80 Leaves of Erythroxylon Coca, Lamarck. Nat. Ord., Lineæ. Constituents: Cocaine and hygrine. Off. Prep.: Extractum Cocæ Fluidum.

*Uses*.—In the preparation of the alkaloid Cocaine and its salts, chiefly the hydrochlorate, largely used as anæsthetic, also in the form of Elixir, Extract, Wine and Infusion. (See Nat. Form.)

*Gelsemium*.—Gelsemium, U. S.—Yellow Jasmine. Rhizome and rootlets of Gelsemium sempervirens, Persoon. Nat. Ord., Loganiaceæ. Constituents: Volatile oil, gelsemine, gelseminic acid and resin. Off. Prep.: Extractum Gelsemii Fluidum; Tinctura Gelsemii.

*Uses*.—“Gelsemin,” a resinoid and an Extract (solid) which represents ten times its weight of the drug.

*Guarana*.—Guarana, U. S.—Paste prepared from crushed seeds of Paullinia Cupana, Kunth. Nat. Ord., Sapindaceæ. Constituents: Caffeine four per cent, tannin, saponin and resin. Off. Prep.: Extractum Guaranae Fluidum.

*Uses*.—In the Various Elixirs, simple and compound. In the powdered form and an Extract, one grain of which represents about four grains of the drug.

*Hydrastis*.—Hydrastis, U. S.—Golden Seal. Rhizome and rootlets of Hydrastis Canadensis, Linne. Nat. Ord., Ranunculaceæ. Constituents: Berberine, hydrastine. Off. Prep.: Extractum Hydrastis Fluidum; Glyceritum Hydrastis; Tinctura Hydrastis.

*Uses*.—“Hydrastin,” a resinoid; being a mixture of the active principles chiefly of berberine (hydrochlor). This term is a misnomer, because of the existence of a second alkaloid in this drug to which the term hydrastine has been applied. The so-called “aqueous fluid extract” is similar to the Glycerite; a colorless solution of the alkaloid Hydrastine and an artificial alkaloid, Hydrastinine, are also used.

*Hops*.—Humulus, U. S.—Strobiles of Humulus Lupulus, Linne. Nat. Ord., Urticaceæ. Constituents: Volatile oil, tannin four per cent, resin, lupuline. Off. Prep.: Tinctura Humuli.

*Uses*.—As Poultice or Plaster, Infusion; and in the brewing of Beer; also an unofficial Extract and Fluid Extract.

*Hyoscyamus*.—Hyoscyamus, U. S.—Henbane. Leaves of Hyoscyamus niger, Linne. Nat. Ord., Solanaceæ. (Should be collected from plants of the second year's growth.) Constituents: Hyoscamine, hyoscine and hyoscipericin. Off. Prep.: Extractum Hyoscyami; Extractum Hyoscyami Fluidum; Tinctura Hyoscyami.

*Uses*.—In the powdered form, but chiefly in the form of Extract and Abstract, about one-third the strength of the extract, formerly official.

*Ipecac.*—Ipecacuanha, U. S.—Root of *Cephaelis Ipecacuanha*, A. Richard. Nat. Ord., Rubiaceæ. Constituents. Emetine, ipecacuanhic acid, resin, etc. Off. Prep.: Extractum Ipecacuanhæ Fluidum; Pulvis Ipecacuanhæ et Opii; Trochisci Ipecacuanhæ; Trochisci Morphinæ et Ipecacuanhæ.

*Uses.*—In the form of powder (as a prompt emetic in doses of ten grains). The Syrup, Tincture of Ipecac and Opium, and Wine of Ipecac (U. S.) are all prepared from the fluid extract.

*Lobelia.*—*Lobelia*, U. S.—Leaves and tops of *Lobelia inflata*, Linne. Collected after flowering, but before seeds are entirely ripe. Nat. Ord., Lobeliaceæ. Constituents: Lobeline, lobelacrin, lobelic acid and resin. Off. Prep.: Extractum Lobeliae Fluidum; Tinctura Lobeliae.

*Uses.*—As Decoction and Infusion; sometimes in the form of powder; also in a number of preparations of the Eclectic school and the Vinegar, formerly official.

*Menispermum.*—*Menispermum*, U. S.—Moonseed, Yellow Parilla, Rhizome and rootlets of *Menispermum Canadense*, Linne. Nat. Ord., Menispermaceæ. Constituents: Berberine, menispine, resin. Off. Prep.: Extractum Menisperni Fluidum.

*Uses.*—Infusion and in several preparations of the Am. Dispensatory.

*Pareira.*—*Pareira*, U. S.—*Pareira Brava*. Root of *Chondodendron tomentosum*, Ruiz and Pavon. Nat. Ord., Menispermaceæ. Constituents: Pelosine, resin. Off. Prep.: Extractum Pareiræ Fluidum.

*Uses.*—In Decoction and Infusion.

*Pepper.*—(See Group 3.)

*Physostigma.*—*Physostigma*, U. S.—Calabar-Bean. Seed of *Physostigma venenosum*, Balfour. Nat. Ord., Leguminosæ. Constituents: Physostigmine, calabarine and physosterin. Off. Prep.: Extractum Physostigmatis; Tinctura Physostigmatis.

*Uses.*—In the preparation of the alkaloid and its official salts.

*Pilocarpus.*—*Pilocarpus*, U. S.—*Jaborandi*. Leaflets of *Pilocarpus Selloanus*, Engler (Rio Janeiro) and *P. Jaborandi*, Holmes (Pernambuco). Nat. Ord., Rutaceæ. Constituents: Pilocarpine, volatile oil. Off. Prep.: Extractum Pilocarpi Fluidum.

*Uses.*—Infusion and in the preparation of the alkaloid Pilocarpine, and its various salts, hydrochlorate, nitrate, etc.

*Pomegranate.*—*Granatum*, U. S.—Bark of Stem and Root of *Punica Granatum*, Linne. Nat. Ord., Lythrarieæ. Constituents: Pelletierine, punicine, tannin, etc.

*Uses.*—In Decoction, and in the preparation of Pelletierine Tannate, both used as remedies for Taenia.

*Sanguinaria*.—*Sanguinaria*, U. S.—Bloodroot. Rhizome of *Sanguinaria Canadensis*, Linne. Nat. Ord., Papaveraceæ. Constituents: Sanguinarine one per cent, resins. Off. Prep.: Extractum *Sanguinariae* Fluidum; Tinctura *Sanguinariae*.

*Uses*.—In the form of powder, as a sternutatory and emetic; also in the preparation of an Extract and as Decoction and a Vinegar, formerly official.

*Scoparius*.—*Scoparius*, U. S.—Broom. Tops of *Cytisus Scoparius*, Link. Nat. Ord., Leguminosæ. Constituents: Scoparin, sparteine, tannin, volatile oil. Extractum *Scoparii* Fluidum.

*Uses*.—A Decoction and the official alkaloid Sparteine (sulph.).

*Spigelia*.—*Spigelia*, U. S.—Pink Root. Rhizome and rootlets of *Spigelia Marilandica*, Linne. Nat. Ord., Loganiaceæ. Constituents: Volatile oil, bitter alkaloidal principle, resin. Off. Prep.: Extractum *Spigeliae* Fluidum.

*Uses*.—Infusion and Decoction, usually associated with purgatives, such as Senna. The Comp. Fluid Extract *Spigelia* and Senna was formerly official for the preparation of "Worm Syrup."

*Staphisagria*.—*Staphisagria*, U. S.—Stavesacre. Seeds of *Delphinium Staphisagria*, Linne. Nat. Ord., Ranunculaceæ. Constituents: Delphinine, delphinoidine, delphisnine and fixed oil.

*Uses*.—Chiefly as an insecticide, the whole seeds being used, and in the form of Tincture.

*Stramonium Leaves*.—*Stramonii Folia*, U. S.—Leaves of *Datura Stramonium*, Linne. Nat. Ord., Solanaceæ. Constituents: Atropine and hyoscyamine, the mixture of the two formerly called daturine.

Stramonium leaves have been superseded by the seeds, these being more active in the official preparations.

*Stramonium Seeds*.—*Stramonii Semen*, U. S.—Seeds of *Datura Stramonium*, Linne. Nat. Ord., Solanaceæ. Constituents: Atropine, hyoscyamine, fixed oil twenty-five per cent. Off. Prep.: Extractum *Stramonii Seminis*; Extractum *Stramonii* Fluidum Seminis; Tinctura *Stramonii Seminis*.

Liquid preparations of Stramonium seed, owing to the considerable quantity of fixed oil they contain, are very prone to precipitation. An Ointment is prepared from the extract.

*Tobacco*.—*Tabacum*, U. S.—Dried leaves *Nicotiana Tabacum*, Linne. Nat. Ord., Solanaceæ. Constituents: Nicotine two to eight per cent, nicotianin, resin, extractive matter.

*Uses*.—In the form of powder, "Snuff." An Ointment is prepared from an aqueous extract of the leaves; Oil of Tobacco by dry distillation.

*Veratrum Viride*.—*Veratrum Viride*, U. S. (American or Green Hellebore.) Rhizome and rootlets of *Veratrum viride*, Solander.

Nat. Ord., Liliaceæ. Constituents: Jervine, pseudo-jervine, rubijervine, veratroidine and resin. Off. Prep.: Extractum Veratri Viridis Fluidum; Tinctura Veratri Viridis.

*Uses.*—A Tincture prepared from the green, or fresh drug, according to the General Formula, Norwood's Tincture.

UNOFFICIAL ALKALOIDAL DRUGS—GROUP EIGHT.

COM. NAME.	BOT. NAME.	PART USED.	CONSTITUENTS.
Achillea (Yarrow)	<i>A. millefolium.</i>	Herb.	Achilleine, resin, volatile oil, tannin.
Alstonia.	<i>A. constricta.</i>	Bark.	Ditaine, ditamine, resin.
Angustura.	<i>Galipea cusparia.</i>	Bark.	Angusturine, resins, vol. oil.
Ash (white).	<i>Fraxinus Americana.</i>	Bark.	Alkaloid, volatile oil.
Baptisia (Wild Indigo.)	<i>Baptisia tinctoria.</i>	Root.	Baptisine, resin, etc.
Barberry.	<i>Berberis vulgaris, aquifolium.</i>	B. Root or Root br'k R'zome.	Berberine, vinetine, etc.
Boldus.	<i>Boldoa fragrans.</i>	Leaves.	Boldine, resin, volatile oil.
Cevadilla.	<i>Veratrum Sabadilla.</i>	Seeds.	Veratrine, cevadilline.
Cicuta.	<i>Cicuta maculata.</i>	Herb.	Cicutine.
Coffee.	<i>Coffea Arabica.</i>	Seeds.	Caffeine, volatile oil, tannin.
Cuprea Bark.	<i>Remijia pendanculata R. Purdicana.</i>		Quinine and other Cinchona alkaloids.
Delphinium (Lark spur).	<i>D. Consolida.</i>	Seeds.	Delphinine, fixed oil, etc.
Gold Thread.	<i>Coptis trifoliata.</i>	Herb.	Berberine, coptine, resin.
Ignatia.	<i>Strychnos Ignatia.</i>	Seed.	Strychnine, brucine, oil.
Jequiriti.	<i>Abrus precatorius.</i>	Seeds.	Alkaloid, abric acid, fixed oil.
Mate.	<i>Ilex Paraguensis.</i>	Leaves.	Caffeine, tannin, volatile oil.
Nectandra.	<i>Nectandra Rodiae.</i>	Bark.	Berberine, sibirine, etc.
Poppy.	<i>Papaver somniferum.</i>	Fruits.	Opium alkaloids (see Opium).
Ptelea (wafer-Ash)	<i>Ptelea trifoliata.</i>	Root bark	Berberine, volatile oil, etc.
Sarracenia (Pitcher plant.)	<i>S. purpurea</i>	Herb and Root	Sarracenine, acids.
Scopolia.	<i>S. Japonica.</i>	Root.	Atropine resin
Theobroma.	<i>Theobroma Cacao.</i>	Seeds.	Caffeine, theobromine, oils.
Veratrum (white Hellebore.)	<i>Veratrum album.</i>	R'zome.	Jervine, pseudo-rubijervine, veratrline, etc.
Xanthorrhiza (Yellow root.)	<i>X. apiifolia.</i>	Root.	Berberine

## Classification of Drugs.

- GROUP NO. I. *Demulcent* Drugs, including those parts of plants whose chief constituents are either Starch, Gum or Sugar or any or all of these together.
- GROUP NO. II. *Refrigerant* or Acid Saccharine Drugs whose constituents are Sugar associated with some acid such as Tartaric, Citric or Malic Acids.
- GROUP NO. III. *Aromatic* Drugs, whose chief constituent is a Volatile Oil sometimes associated with a resin.
- GROUP NO. IV. *Resinous* Drugs whose chief constituent is Resin which may be associated with Volatile or acrid Fixed Oil, tannin and bitter principle.
- GROUP NO. V. *Oily* Drugs whose principal constituent is a bland Fixed Oil or Fat usually associated with gum, or mucilage.
- GROUP NO. VI. *Astringent* Drugs whose principal constituents are Tannic, or Gallic Acid, or both, sometimes associated with volatile oil, resin or other principles.
- GROUP NO. VII. *Glucosidal* Drugs in which the most active medicinal constituents are Glucosides or glucosidal. It embraces Drugs furnishing the Neutral or "bitter" principles as well as the Glucosides. Also the class termed Reactionary Drugs.
- GROUP NO. VIII. *Alkaloidal* Drugs, in which the most active constituents are Alkaloidal, i. e., yielding one or several Alkaloids.
- GROUP NO. IX. *Animal* Drugs, including medicinal Animals and Animal products and derivatives not otherwise classified.

## Animal Drugs, Group IX.

As Animal Drugs are here included those substances of animal origin not heretofore treated of, or classified as having special properties. They embrace:

Whole animals, as Cantharis and Coccus and  
Secretions, as Musk, Oxgall, Milk, Egg, Isinglass and  
The Ferments Pepsin and Pancreatin.

*Cantharis*.—Cantharis, U. S.—“Spanish Flies.” Whole animal of *Cantharis vesicatoria*, DeGeer. Nat. Ord., Coleoptera of the class Insecta. Constituents: Cantharidin. Off. Prep.: Ceratum Cantharidis; Collodium Cantharidatum; Tinctura Cantharidis.

*Uses*.—Chiefly in the form of Cerate for spreading “Blisters,” also in Linimentum Cantharidis, formerly official.

*Cochineal*.—Coccus, U. S.—Dried female of *Coccus cacti*, Linne. Nat. Ord., Hemiptera of the class Insecta. Constituents: Carminic acid. Off. Prep.: Tinctura Cardamomi Comp.

*Uses*.—In Comp. Tincture Cochineal, N. F., for coloring Elixirs and for preparing Carmine, which is a compound of the coloring principle with alumina, etc.

*Oxgall*.—*Fel Bovis*, U. S.—“Fel Tauri.” Fresh gall of *Bos Taurus*, Linne. Nat. Ord., Ruminantia of the class Mammalia. Constituents: Bilirubin, cholesterin, glycocholic and taurocholic acids.

*Fel Bovis Purificatum*, U. S.—Inspissated and Purified Oxgall, U. S. Ph. '80. Prepared by evaporating the liquid Oxgall to one-third its weight, adding an equal volume of Alcohol. The alcoholic solution, freed from the precipitated impurities, is then concentrated by evaporation to a pilular consistence.

*Uses*.—Exceedingly rare; sometimes in pills.

*Isinglass*.—*Ichthyocolla*, U. S.—Swimming bladder of *Acipenser Huso*, Linne, and other species of the same genus. Nat. Ord., Sturiones of the class Pisces. Constituents: Gelatin. Off. Prep.: Emplastrum Ichthyocollæ.

*Uses*.—In the preparation of “Court Plaster” and as a clarifying agent in beer brewing, etc. Russian Isinglass is the most valuable and is the kind chiefly employed. American Isinglass is prepared from the sounds of the Hake; it is inferior to the first-mentioned and much cheaper.

*Musk*.—*Moschus*, U. S.—Dried secretion from preputial follicles of male of *Moschus moschiferus*, Linne. Nat. Ord., Ruminantia of the class Mammalia. Constituents: Cholesterin, fat, ammonia, albu-

minous and gelatinous substances, etc. Off. Prep.: Tinctura Moschi.

*Uses.*—In Flavoring and Perfumery; seldom in medicine, as a nervous sedative.

*Pepsin.*—Pepsinum, U. S.—Pure Pepsin. A proteolytic Ferment, or enzyme, obtained from the glandular layer of fresh Stomachs from healthy Pigs; the chief digestive principle of the gastric juice.

It should be capable of digesting not less than 3,000 times its own weight of freshly coagulated and disintegrated Albumen when tested by the official process.

Pepsin is obtained from the finely comminuted *inner* lining, or membrane, of the Hog's stomach by macerating it in Water containing about 2 per cent Hydrochloric Acid, expressing and filtering the liquid and obtaining the pepsin by either of the following methods:

*Scheffer's process.*—The solution is saturated with Sodium Chloride, through which the pepsin is thrown out of solution and rises to the surface of the liquid from which it is transferred to a strainer and the adhering liquid removed by expression. The residue consists of pepsin associated with other products of the action of acid on albumen, *syntonin*, and the result of the digestive effect of the pepsin on the albumen, *peptone* and *parapeptone*. To free the pepsin from these by-products is very difficult and has never been entirely effected, absolutely pure pepsin not yet having been produced.

Upon the small masses, resulting from drying the residue, the adhering salt crystallizes and is removed by immersion in water. The pepsin is purified by re-solution in Acidulated Water and re-precipitation with Salt. It may also be precipitated with Alcohol, pepsin being insoluble in liquids containing 40 per cent alcohol. This pepsin is dissolved with great difficulty and has been used chiefly in the powdered form, made by adding Sugar of Milk to the freshly precipitated pepsin, drying and powdering and adjusting its strength by the addition of Milk Sugar.

*Pepsinum saccharatum.*—Saccharated Pepsin of the strength of 1 in 10 of Milk Sugar, 1 gr. dissolving 300 grs. albumen, is also official.

*Soluble Pepsins* are made from the Acid Solution obtained as above, or by digesting the membrane with the Acidulated Water at a gentle heat, and neutralizing the expressed liquid, filtering and evaporating it to a syrupy consistency and then obtaining the product in the form of transparent scales by spreading it upon plates of glass and heating in a drying closet. There are many modifications of this process, whereby it is claimed products of greater purity and strength are obtained. These depend upon limiting the formation of the by-products referred to, by the use of Sulphurous Acid, etc.

These pepsins consist chiefly of peptone, and rapidly deteriorate and assume a disagreeable animal, glue-like odor; they have the advantage of being very soluble in Water, without the addition of acid, and are therefore well adapted to the preparation of liquids, elixirs, etc. They are very hygroscopic and must be kept in tightly closed-vessels, in a cool and dry place.

The process for the *valuation of Pepsin* consists in determining its *proteolytic* power, or the ratio of its decomposing or digestive effect upon proteids, especially albumen and fibrin. Pepsin in acid solution and at the body temperature, 38° to 40°C., (100 to 104°F.) digests proteid substances, converting them into a soluble, readily assimilable form called *peptone*.

The test is effected by adding 10 Gm. freshly coagulated and prepared Egg-white to 100 C.C. of Water containing 2 C.C. of Dilute Hydrochloric Acid and  $\frac{1}{3}$  cg. ( $\frac{1}{2}$  gr.) of Pepsin, heated to 40°C. The mixture is kept at this temperature and agitated every 15 minutes, when, at the expiration of 5 or 6 hours, all the Albumen should have been digested and the mixture have resulted in an almost clear solution. By varying the strength of the solutions, the variation in power of any pepsin may be ascertained.

The process may be effected in 15 minutes by adding the Egg-white directly to the Water, coagulating and disintegrating it by boiling and stirring and then adding the cooled mixture to the acid solution of Pepsin and maintaining it at a temperature of 55°C., constantly shaking it.

*Pancreatin.*—Pancreatinum, U. S.—A mixture of enzymes naturally existing in the Pancreas (sweetbread) of warm-blooded animals, usually from that of the Hog (and Calf).

It is prepared by different methods: By maceration with acidulated Water, neutralization with Calcium Carbonate, precipitation of the clear liquid with Alcohol, collecting, drying and mixing the residue with Sugar of Milk.

The *scaled* form is prepared by extraction, freeing from fat by washing with Ether and drying on plates of glass.

Pancreatin peptonizes milk, and 0.28 of it dissolved in 100 C.C. of tepid Water, with 1.5 of Sodium Bicarbonate, added to 400 C.C. of Milk, heated to 40°C. and the mixture maintained at this temperature for thirty minutes, the milk should be so completely peptonized that a little of it, transferred to a test-tube, should show no coagulation with Nitric Acid.

*Ptyalin.*—A Ferment present in the Saliva; has the same properties as Diastase, obtained from malt.

*Uses.*—The above three Principles represent the three fermentative stages of the process of digestion:

Ptyalin has amyloolitic properties, that is, converts Starch and Carbohydrates generally into *glucose*, into which all amyloid and saccharine substances must be changed before they can be assimilated.

Pepsin, secreted by the stomach, in conjunction with Hydrochloric Acid (and Lactic Acid) digests all albuminous substances into the form necessary to their assimilation, *peptone*.

Pancreatin is a mixture of principles representing the properties of the two preceding Ferments and in addition possesses the property in alkaline media to *emulsify* Fats, thus facilitating their assimilation.

The Pulvis Pepsini Compositus, N. F., "Pulvis Digestivus," is a mixture of

the different principles with Milk Sugar and Hydrochloric and Lactic Acids to represent the Digestive Fluids in their natural proportions. Pepsin is largely used in the powdered form, also in tablets, etc., in Elixirs, Wines, Glycerite, and Solutions. (See Nat. Formulary.)

*Milk.*—*Lac Vaccinum.*—Secretion of the character of an Emulsion obtained from the Cow yields an organic acid:

*Lactic Acid.*— $\text{HC}_3\text{H}_5\text{O}_3$ ,—Acidum Lacticum, U. S.—Containing 75 per cent by weight of absolute acid; sp. gr. 1.213.

It is formed in Milk when it sours by the fermentation of the Sugar of Milk, and may be formed in solutions of various other Sugars by fermentation in the presence of casein and certain other proteid compounds resembling it. The Lactic Acid so formed is combined with Calcium or Zinc, the Lactate separated and decomposed by strong Acids which set the Lactic Acid free.

A syrupy liquid miscible in all proportions with water, alcohol and ether, but not with benzin or chloroform.

*Off. Prep.*—Syrupus Calcii Lactophosphatis.

*Yolk of Egg.*—*Vitellus*, U. S.—Yolk of Egg of Gallus Bankiva, var. domesticus, Temminck. Nat. Ord., Gallinæ of the class Aves. Constituents: Vitellin, fixed oil, inorganic salts, etc. Off. Prep.: Glyceritum Vitelli.

*Uses.*—For preparing Emulsions, especially with strongly alcoholic liquids, for example, spirit nitrous ether, in which Acacia would precipitate.

## UNOFFICIAL ANIMAL DRUGS, GROUP NINE.

COM. NAME.	SCIENTIFIC NAME.	PART USED.	CONSTITUENTS.
Ambergris.	Ambra Grisea.		Ambrin, etc.
Blatta.	Blatta Orientalis.	Insect.	Antihydropin, fats, etc.
Castcreum.	Castor Fiber.	Gland'l'r Secret'n	Vol. oil, castorin, sa- licine, etc.
Civet.	Viverra Zibetha, V. Civetta.	or Gland'l'r Secret'n	Vol. oil, fat, resin, salts, etc.
Bone.	Os.		Calcium phosphates, carb. Mag. phos. etc.
Coral.	Corallium rubrum	and Calc. skele- ton.	Calcium carb., Mag- nesium carb., etc.
Cuttle-bone.	Oculina Virginica. Os Sepiae.	Calc. skele- ton.	Calcium carb., Mag- nesium carb. Phos- phates (traces).
Gelatin.	Gelatina.		(Glue consists of gel- atin, chondrin and various impurities).
Hyraceum.	Hyrax Capensis.	Excr. or Secre- tion.	Vol. oil, resin, fat, various acids and salts.
Sponge.	Spongia officinalis.	Horny skeleton or Ash.	Spongian, various salts, including iodides.

## ARTIFICIAL ALKALOIDS.

The *Pyridin* bases obtained from the tarry residue in the destructive distillation of Nitrogenous substances, such as Bone, or made synthetically. They are colorless, strongly alkaline liquids of penetrating odor, forming salts with acids. The most important are:

*Pyridin*.— $C_5H_5N$ —and its homologue *Pyrrol*,  $C_4H_5NH$ .

*Iodol*.— $C_4I_4NH$ .—Tetra iodo pyrrol. Made by mixing alcoholic solutions of Pyrrol and Iodine and separating the Iodol by the addition of water. Contains 98% iodine.

*Uses*.—As an inodorous substitute for Iodoform.

The *Chinolin* bases—Chinoline  $C_9H_7N$ —a colorless liquid, forming salts with acids; the Tartrate has been used. Also a number of derivatives.

*Kairin*.— $C_{11}H_{15}NO.HCl$ .—Known as "A" and "M."

*Thallin*.— $C_9H_9(OCH_3)NH$ —From Paranitrophenol. The Sulphate; soluble in 7 water; 100 alcohol.

*Antifyrin*.— $C_{11}H_{12}N_2O$ .—Dimethyl-Phenyl-iso-Pyrazolon. From Phenylhydrazin with acetic ether, etc. Soluble in 1 part of water, alcohol or chloroform, in 50 parts of ether. Solution colored red by Ferric chloride.

## ANIMAL ALKALOIDS.

From fresh meat an alkaloid *creatinin*  $C_5H_{10}N_4O$  has been obtained and a number of derivatives of it.

Ptomaines, also called Septicine, are alkaloids produced in the Cadaver by decomposition of albumen or as the result of bacterial changes. Some are exceedingly poisonous, others are non-poisonous.



# Solutions.

Solutions may be divided, according to the character of the solvent employed, into groups of *aqueous*, *alcoholic*, *saccharine* and *ethereal* solutions, and Glycerites and Oleates.

The Aqueous solutions embrace two classes: The Waters and the Liquors or pharmacopœial Solutions.

## WATERS—AQUÆ.

The Waters are solutions of *volatile* substances in Water.

The nineteen official Waters may be divided, according to their character or method of preparation, as follows:

### 1. Natural Waters:

*Aqua.*—Water, H<sub>2</sub>O.—Natural water in its purest attainable state.

2. The Aromatic Waters.—Solutions of Essential Oils or other *volatile* principles in Water. With one exception (Aq. Amygdal. am.), they are saturated solutions and are as follows:

#### (a) By simple solution:

Aqua:	% by vol.
Amygdalæ Amaræ . . . . .	bitter almond oil 0.1
Creosoti . . . . .	creosote 1.
Chloroformi . . . . .	chloroform (in excess) about 0.5
Aurantii Florum . . . . .	dist. water 50. stronger orange flower water 50.
Rosæ . . . . .	dist. water 50, stronger rose water 50.

#### (b) Solution by intervention of Calcium Phosphate and filtration:

Aqua:	% by vol.
Anisi . . . . .	anise oil 0.2
Cinnamomi . . . . .	cinnamon oil 0.2
Foeniculi . . . . .	fennel oil 0.2
Menthæ Piperitæ . . . . .	peppermint oil 0.2
Menthæ Viridis . . . . .	spearmint oil 0.2
Camphoræ . . . . .	alcohol 0.5, camphor 0.8

The oils are triturated with twice their weight of precipitated calcium phosphate, the water gradually added and the mixture filtered. Camphor is first reduced to powder with a little alcohol.

#### (c) By distillation:

*Aqua Destillata.*—Distilled Water.—By distilling Water, rejecting the first 10 per cent of the distillate, collecting the succeeding 80 per cent and preserving it in bottles, loosely stoppered with cotton.

**Aqua Aurantii Florum Fortior. Aqua Rosæ Fortior.**

These are made by distillation from the fresh Orange flowers and Rose leaves, respectively, and obtained chiefly as by-products in the manufacture of their essential oils.

The Aromatic Waters may also be prepared by the *hot-water* method: Introducing the Oil, dropped on a folded filter, in hot water, shaking the container, allowing it to stand until thoroughly cold and obtaining the water by filtration.

**3. Chemical Waters.**—Solutions of Gases in Water, made by chemical reaction and absorption. All but Ammonia Water are saturated solutions:

	<i>Sp. gr.</i>	<i>% by w't.</i>
Aqua Ammoniæ . . . . .	0.960	NH <sub>3</sub> —10.
Ammoniæ fortior . . . . .	0.900	NH <sub>3</sub> —28.
Chlori . MnO <sub>2</sub> +4HCl=MnCl <sub>2</sub> +Cl <sub>2</sub> +2H <sub>2</sub> O		Cl— 0.4
Hydrogenii Dioxidi . 1 vol. eq. 10 vols.O		H <sub>2</sub> O <sub>2</sub> — 3.

The preparation of these and the reactions involved have been described under the Elements from which they are respectively produced.

**SOLUTIONS—LIQUORES.**

The twenty-four official Solutions are solutions of *non-volatile* substances, chemical salts, in Water. They are divided into two Groups:

(1) Simple solutions. (2) Chemical solutions.

1. Simple Solutions are prepared by dissolving the substance in water. Three are prepared by volume:

Liquor:	<i>% by vol.</i>
Acidi Arseniosi . . . . . (HCl 5) acid arsenous	1.
Arseni et. Hydrargyri Iodidi . . . . . arsenic iodide	1.
(Donovan's)	mercuric iodide 1.
Sodii Arsenatis . . . . . sodium arsenate	1.

*% w't.*  
Iodi Comp. . . . . potassium iodide 10, iodine 5.

2. Chemical solutions: These include all those solutions made by forming new chemical compounds, either by double decomposition, direct union or other chemical methods.

The weaker of these being used internally, are prepared by *volume*; the stronger ones, chiefly used for the production of other compounds and preparations, are made by *weight*.

Prepared by volume:

Liquor:	<i>% by vol.</i>
Ammonii Acetatis . . amon. carb. 5, acid acet. NH <sub>4</sub> C <sub>2</sub> H <sub>3</sub> O <sub>2</sub>	7.
Calcis . . . . . lime 0.3, water 100, Ca(OH) <sub>2</sub>	0.17
Ferri et Ammonii Acetatis . . . . . sol. amon. acet.	20.
(Basham's Mixture)      acid acetic dil. 3, tr. ferric chl.	2.
	arom. elixir 10, glycerin 12.

## (Liquores, continued.)

% by vol.

Plumbi Subacetatis dilutus . . . . .	sol. lead subacetate	3.
Potassii Arsenitis . . . . .	potass. bicarb 2, acid arsenous (Fowler's)	1.
Potassii Citratis . . . . .	tinct. lavender comp.	3.
Magnesii Citratis . . . . .	magnes. carb. 15 G., acid citric 30 G., syrup acid citric 60 C.C., potass. bicarb. 2.5, water to 350 c.c. for one bottle.	9.

Prepared by weight:

## Liquor:

% by w.t. Sp. gr.

Hydrargyri Nitratis . . . . .	red mercuric oxide 40,	
	HNO <sub>3</sub> 45, Hg (NO <sub>3</sub> ) <sub>2</sub>	60. 2.100
Plumbi Subacetatis . . . . .	lead acet. 17, lead oxide 10	25. 1.195
Potassæ . . . . .	potass. bicarb. 8.5, lime 4, KOH	5. 1.036
Sodæ . . . . .	sod. carb. 17, lime 5, NaOH	5. 1.059
Sodæ Chloratæ . . . . .	sod. carb. 15, lime chlorin 7.5, Cl	2.6 1.052
Sodii Silicatis . . . . .	sodium silicate	50. 1.3-4
Zinci Chloridi . . . . .	zinc 24, HCl 84, HNO <sub>3</sub> 12, ZnCl <sub>2</sub>	50. 1.535

The Iron Solutions are made by acting on the metal with the respective acids; Hydrochloric Acid to produce the Chloride and Sulphuric Acid to produce the Sulphate.

These are *ferrous* salts and are oxidized into *ferric* salts by Nitric Acid:

## Liquor

% by w.t. Sp. gr.

Ferri Chloridi . . . . .	HCl 5, Fe <sub>2</sub> Cl <sub>6</sub>	37.8 1.387
Ferri Subsulphatis . . . . .	(Monsell's) subsulphate	43.7 1.550
Ferri Tersulphatis . . . . .	Fe <sub>2</sub> (SO <sub>4</sub> ) <sub>3</sub>	28.7 1.320

By precipitation with Ammonia Water, washing, etc:

Ferric Hydrate, Fe<sub>2</sub>(OH)<sub>6</sub>, from which, by solution in their respective Acids the following are produced:

## Liquor

% by w.t. Sp. gr.

Ferri Acetatis . . . . .	Fe <sub>2</sub> (C <sub>2</sub> H <sub>3</sub> O <sub>2</sub> ) <sub>6</sub>	31. 1.160
Ferri Citratis . . . . .	Fe <sub>2</sub> (C <sub>6</sub> H <sub>5</sub> O <sub>7</sub> ) <sub>2</sub>	42.5 1.250
Ferri Nitratis . . . . .	Fe <sub>2</sub> (NO <sub>3</sub> ) <sub>6</sub>	6.2 1.050

From the solution of the Citrate, the scaled salts are prepared. All the solutions of iron have a characteristic reddish-brown color, except that of the Nitrate, which is amber-colored.

## SPIRITS—SPIRITUS.

The Spirits are Alcoholic solutions of *volatile* substances.

Of the 25 official, two are "natural" spirits (made by distillation: Spiritus Frumenti and Sp. Vini Gallici and are treated of as "Products by Fermentation"), fifteen are solutions of essential oils and called "Aromatic Spirits," or, when used for flavoring, "essences"; in some of the last mentioned, Deodorized Alcohol is used as the solvent:

1. Natural Spirits, by distillation:	% by w't.	% by vol.
Spiritus Frumenti containing alcohol . . . . .	44 to 50	50 to 58
Spiritus Vini Gallici    "    "    . . . . .	39 to 47	46 to 55
2. Made by solution:		% by vol.
Spiritus Ætheris . . . . . ether ( $C_2H_5)_2O$		32.5
Spiritus Ætheris Comp. . . . ethereal oil 2.5, ether (Hoffmann's anodyne)		32.5
Spiritus Chloroformi . . . . . chloroform		6.
Aromatic Spirits or "Essences."		
<b>Spiritus:</b>		% by vol.
Amygdalæ Amaræ (water 20) . . . bitter almond oil		1.
Anisi (alcohol deod.) . . . . . anise oil		10.
Aurantii    "    "    . . . . . orange oil		5.
Aurantii Comp (alcohol deod.) . . . . . orange oil oils, anise 0.5; coriander 2, lemon oil		20.
Camphoræ . . . . . camphor		10.
Cinnamomi . . . . . cinnamon oil		10.
Gaultheriæ . . . . . wintergreen oil		5.
Juniperi . . . . . juniper oil		5.
Juniperi comp. (water 30) . . . . . juniper oil oils, caraway, fennel, each		0.4 0.05
Lavandulæ (alcohol deod.) . . . . . lavender oil		5.
Limonis    "    "    . . . . . lemon peel 5, oil		5.
Menthae Piperitæ . . . . . peppermint herb 1, oil		10.
Menthae Viridis . . . . . spearmint herb 1, oil		10.
Myrciaæ . . . . . water 38, oil of bay oils, orange, pimenta, each		0.8 0.05
Myristicæ . . . . . nutmeg (vol.) oil		5.
3. By digestion:		% by vol.
Spiritus Phosphori . . . absolute alcohol, phosphorus		0.12
4. By chemical reaction and solution:		
Spiritus Ammoniæ Aromaticus . water 14, amon. water amon. carb.		9 3.4
oils, lavender, nutmeg each 0.1; lemon oil		1.

% by w't.

Spiritus Glonini . . . . .	nitroglycerin, C <sub>3</sub> H <sub>5</sub> (NO <sub>3</sub> ) <sub>3</sub>	1.
5. By distillation and absorption (from amon. water, stronger):		
Spiritus Ammoniae . . . . .	amon. gas, NH <sub>3</sub>	10.
6. By chemical reaction, distillation and solution:		
Spiritus Aetheris Nitrosi . . . . .	ethyl nitrite	4.
	(yielding 11 times its vol. of NO.)	

From reaction of Sulphuric Acid on Sodium Nitrite in Alcohol:



The Nitrous Ether is separated by distillation in a glass-retort, fitted loosely in a receiver, the entire neck of the retort being kept cold with ice-water, according to the method noted under "Distillation." The distillate is separated from the accompanying alcohol by washing with ice-cold water and traces of acid by agitation with an ice-cold solution of Sodium Carbonate, then freed from adhering water by shaking it with Potassium Carbonate and filtered in a tared bottle containing the alcohol.

Its strength of Ethyl Nitrite is determined by measuring the volume of Nitrogen Dioxide (NO) given off, when decomposed by Potassium Iodide and Sulphuric Acid: C<sub>2</sub>HI<sub>5</sub>NO<sub>2</sub> + KI + H<sub>2</sub>SO<sub>4</sub> = C<sub>2</sub>H<sub>5</sub>OH + KHSO<sub>4</sub> + I + NO, in an instrument termed a *nitrometer*.

## SYRUPS—SYRUPI.

The official Syrups are nearly *saturated* solutions of Sugar in Water, in which aromatic or medicinal substances are dissolved.

The official Syrup contains 65 per cent by weight, 85 per cent by volume, of Sugar (about 7 lbs. av. in 1 Gallon): with a smaller proportion of Sugar the syrup undergoes fermentation (spoils).

The "Medicated Syrups" contain less syrup owing to the solution of the medicinal substances which usually reduce the solubility of the sugar in the liquid from which the syrup is prepared. Syrups should be made in small quantities and be kept in a *cool* place, in cork-stoppered bottles in order to *preserve* them.

The thirty-two official Syrups are made by different methods: By solution, or mixing the medicinal substance with the syrup; by dissolving the Sugar in the medicinal solution; by extraction from the drug and by chemical reaction and solution.

The methods of dissolving the Sugar are also of importance; in some it is dissolved *without heat*, in others *with heat* and with some others by *boiling* heat.

## (1) By Solution of Sugar in the liquid:

Syrpus . Sugar 850 Gm.; Distilled Water, to make 1000 C.C.  
Without heat:  
Syrpus Aurantii Florum . . . . . Sugar 850 Gm.  
Orange Flower Water to make 1000 C.C.

## (2) By mixing a Solution with Syrup:

Syrpus:	<i>No. of cc. in 100 of Syr., or % by vol.</i>
Acaciæ . . . . .	mucilage acacia 25.
Acidi Citrici . . .	spirit lemon 1, acid citric (water 1) 1.
Krameriae . . . . .	fluid extract 45.
Rhei . . . . .	fluid extract (pot. carb. 1, water 5) 10. spirit of cinnamon (glyc. 5) 0.4
Rhei Aromaticus . . . . .	tincture rhubarb arom. 15.
Rosæ . . . . .	fluid extract 12.5
Rubi . . . . .	fluid extract 25.

## By solution and filtration:

Sugar dissolved by heat:

Syrpus:	<i>% by vol.</i>
Sarsaparillæ Comp . . . . .	fl. ext. sarsaparilla 20.
	fl. ext. glycyrrh. senna, each 1.5
	oils, sassafras, anise, gaultheria, each 0.01
Scillæ . . . . .	vinegar squill (clarified) 45.

Sugar dissolved without heat: % by vol.

Ipecacuanhae . . . fl. ext. (acid acetic 1, glycerin 10) 7.

Senegæ . . . . . fl. ext. (ammonia water 0.5) 20.

By solution, filtration with Calcium Phosphate:

Solution of Sugar without heat:

Syrups: % by vol.

Lactucarii . . . . . tincture lactucarium 10

Scillæ Comp . . . . fluid extract squill, senega each 8.

(Coxe's Hive Syrup) Antimony and potassium tartrate 0.2

Tolutanus . . . . . bals of tolu (sol. in alcohol 5) 1.

Zingiberis . . . . . fluid extract (evap. of alcohol) 3.

(3) By extraction:

Sugar dissolved without heat: % by vol.

Syrups:

Allii . . . . . dilute acetic acid 20.

Altheæ . . . . . water 40; alcohol 3; glycerin 10 5.

Amygdalæ . . . . . (bitter 4; sweet almond 14) 18.  
orange flower water 10.

Pruni Virginianæ . . . . . glycerin 15, wild cherry 15.

By extraction with heat:

Sugar dissolved without heat:

Sennæ . . . . . alcohol 15, ol. coriand. 0.5 25

Sugar dissolved by heat

Picis Liquidae . . . . . glycerin 10 7.5

By digestion and filtration with Calcium Phosphate:

Sugar dissolved without heat:

Aurantii . . . . . alcohol 10, fresh exterior rind 5.

By extraction and fermentation:

Sugar dissolved by heat: % by weight.

Syrups Rubi Idæi . . . . . filtered juice 40.

(4) Chemical Syrups:

By simple solution:

Sugar dissolved without heat: grs. in % by vol.

Syrups: grs. in % by vol.  
q.c.c., 1 fl. dr.

Hypophosphitum . . . calcium hypophosphite 3 4.5

                          potassium, sodium hypophosphite each 1 1.5

                          spirit lemon 0.5, acid hypophos. dil. 0.2

Hypophosphitum cum Ferro . . ferrous lactate 1.

                          with potass. citrate 1, in syrup. hypophosph.

By chemical reaction and solution:

Sugar dissolved without heat:

*% vol.*

Syrupus Calcii Lactophosphatis . . . calcium lactophosphate 1.

Calc. carb. 25 G. dissolved in Acid Lactic 60 C.C. and Water 100 c.c.; add Acid Phosphoric 36 c.c. and Water 150 c.c.; filter, add Water to 425 c.c., then Orange flower water 25 c.c., and in this dissolve Sugar 700 G. to make 1,000 c.c.

Sugar dissolved by boiling heat:

Syrupus Calcis . . . . . calcium saccharate 1.

Mix Lime 65 G. with Sugar 400 G., add to 500 c.c. boiling Water and boil for 5 minutes; strain and dilute with an equal volume of Water, filter, evaporate to 700 c.c. and when cool add Water to make 1,000 c.c.

Solution mixed with cold Syrup:

*% by weight.*

Syrupus Acidi Hydriodici . . . . . absolute acid, HI 1.

Dissolve Potass. Iodide 13 G. and Potass. Hypophosphite 1 G. in Water 15 c.c.; mix with solution of Acid Tartaric 12 G. in Alcohol dilute 25 c.c., separate the liquid from the precipitate by filtration, concentrate it by evaporation to 50 G. and add to it Syrup, to make 1,000 G.

Syrupus Ferri Iodidi . . . . . ferrous iodide,  $\text{FeI}_2$  10.

To Iron wire 25 G. and Water dist. 150 c.c. add Iodine 83 G.; filter the greenish colored liquid, after first heating it to boiling, into 600 G. Syrup, wash filter with a mixture of 25 c.c. each of water dist and syrup, then add Syrup to make 1,000 Gm.

*grs. in 4 cc., % by vol.*

Syrupus Ferri Quininæ et Strychninæ                                   *1 fl. dr.*

Phosphatum:	ferric phosphate, soluble	$1\frac{1}{2}$	2.
	quinine sulphate	2	3.
	strychnine	$\frac{1}{90}$	0.02
	acid phosphoric	3	4.8

Dissolve Ferric Phosphate 20 G. in Water 50 c.c. with heat, add the Acid Phosphoric 48 c.c., Quinine 30 G. and Strychnine 2 decg.; stir until dissolved, filter the liquid into Glycerin 100 c.c. and add Syrup to make 1,000 c.c.

### HONEYS—MELLITA.

There is only one medicated Honey official.

*Mel* or crude honey and *Mel Despumatum* or clarified honey are described under "Sugars."

*Mel Roseæ*.—Honey of Rose, fl. ext. rose 12, clarified Honey to make 100 G.

## ELIXIRS—ELIXIRIA.

Elixirs are a class of elegant preparations similar to wines or cordials, composed of Water, Sugar, Alcohol and Aromatics.

The medicinal substances are usually in such proportion that an ordinary dose may be contained in one or two teaspoonfuls of the elixir.

There are but two Elixirs official: Aromatic Elixir, which serves as a vehicle and one medicinal, Elixir of Phosphorus. Formulas for the most common elixirs are given in the National Formulary (N. F.).

Elixir Aromaticum . . . . .	spirit of orange comp	12.c.c.
mix with . . . . .	Alcohol deodorized, to make	250 c.c.
to this solution add in several portions, agitating after each addition . . . . .	syrup	375 c.c.
and in the same manner . . . . .	water	375 c.c.
mix the liquid with .	precipitated Calcium phosphate	15 G.
and filter adding . . .	Water 3, Alcohol 1, to make	1000 c.c.

This illustrates the method by which Elixirs are made. The medicinal ingredients are dissolved in the water, or alcohol, as indicated by their solubilities, before mixing the alcoholic solution of oils with the saccharine solution.

Some salts and fluid extracts may be dissolved in or mixed with the elixir itself.

Elixir Phosphori: glyc. 55, anise oil 0.2, sp. phosphorus	21 c.c.
mix by agitation; then add . . . . aromatic Elixir to	100 c.c.

This Elixir contains of phosphorus 25 mg. in 100 c.c.; or 1 mg. ( $\frac{1}{35}$  grain) in 4 c.c., 1 fl. dram.

## GLYCERITES—GLYCERITA.

The Glycerites or "Glyceroles," are solutions of substances in Glycerin.

There are six Glycerites official and they are classified, according to the methods of preparation, as follows:

By solution:  $\%$  by w't.

Glyceritum Acidi Carbolic . . . . . acid carbolic 20.

Glyceritum Vitelli . . . . . fresh egg yolk 45.

By solution with heat:  $\%$  by w't.

Glyceritum Acidi Tannici . . . . . acid tannic 20.

Glyceritum Amyli . . . . . water 10, starch 10.

By extraction, evaporation and solution:

Glyceritum Hydrastis . . . hydrastis (alcohol, water 25) 100.

To the Hydrastis extract obtained with Alcohol, the Water is added, the alco-

hol removed by evaporation, Water added to make 50 c.c. of filtered liquid freed from insoluble matter and Glycerin to 100 c.c.

By chemical reaction and solution:

Glyceritum Boroglycerini; boroglyceride, or glyceryl borate, 50 per cent by weight.

Glycerin 46 G., heated to 150°C.. Acid Boric 31 G., added in portions and heated until reaction ceases and product weighs 50 G., then add Glycerin to 100 G.

### OLEATES—OLEATA.

The official Oleates are solutions of oleates in Oleic Acid.

They are distinct from the solid oleates which are made by double decomposition of salts of the metals and alkaline earths and sodium oleate, or Soap. (See Soap.)

Three are official, two liquid and one, Zinc oleate, semi-solid.

They are made by incorporating the solid with the Oleic Acid, contained in a warm mortar and effecting solution with a gentle heat:

	% by w.t.
Oleatum Hydrargyri . . . . .	yellow mercuric oxide 20.
Oleatum Veratrinæ . . . . .	veratrine 2.
Oleatum Zinci Oxidi . . . . .	zinc oxide 5.

### COLLODIOS—COLLODIA.

These preparations are made by adding medicinal agents to Collodion (see Pyroxylin). They are prepared:

By solution:

Collodium . . . solution in ether 75, alco. 25, pyroxylin	3.
Collodium Flexile . . . castor oil 3, Canada turpentine	5.
Collodium Acidi Tannici . . alco. 5, ether 25, acid tan.	20.

By extraction, evaporation and solution:

Collodium Cantharidatum . . . (flex. collo.) cantharides	60.
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# The Mixtures.

The second division embraces such liquid preparations as are not clear solutions and also solutions made by solvents other than those included in the division of Solutions and ineligible to classification according to the solvents.

They are represented by three classes: Mixtures, Emulsions and Liniments.

## MIXTURES—MISTURÆ.

The four official mixtures are liquid preparations, for internal use, of medicinal substances, dissolved or suspended in water, containing sugar, gum, or glycerin. They should be prepared extemporaneously.

By solution:

	% vol.
Mistura Glycyrrhizæ Comp. . . . . pure extract glycyrrhiza	3.
(Brown Mixture) Spirit ether nitros 3, wine antimony	6.
	tinct. opium camph. 12.
	syrup 5, mucilage acacia 10, water, to 100.
Mistura Rhei et Sodæ . . . . . sodium bicarbonate	3.5
	fl. exts. ipecac 0.3, rhubarb 1.5
	spirit peppermint 3.5, glycerin 35, water, to 100.

By suspension:

Mistura Cretæ . . . . . . . comp. chalk powder	20.
(Chalk Mixture) cinnamon water 40, water, to 100.	

By chemical reaction and solution:

Mistura Ferri Comp. . myrrh, sugar, each 1.8, potass. carb.	0.8
	triturate with rose water 70, sp. lavend.
(Griffith's Mixt.) ferrous sulph. 0 6 and rose water, to 100.	

## EMULSIONS—EMULSA.

The Emulsions are liquid preparations consisting of oily, fatty, resinous, or otherwise insoluble substances suspended in watery liquids by the intervention of gum, mucilage or other viscid material called emulsifying agents.

They may be divided into (1) Natural and (2) Artificial Emulsions.

With Natural Emulsions are included all products of animal or vegetable origin, consisting of oily or resinous substances so combined with gum or albumen as to be readily miscible with water without separation.

Of animal products, Milk and Egg Yolk, are the most typical emulsions, since their fat-globules are so finely divided and so perfectly distributed in the watery liquid as to require considerable agitation to separate them from the albuminous envelope, in order to obtain the fat. The operation of "churning" milk to produce Butter is a good illustration of this and is the *reverse* of the process of emulsification.

The milk-juice of many plants, consisting of oil and gum or albumen, is deposited in fruits and seeds upon evaporation of the water. The nuts, especially Almonds, are rich in this mixture, which, upon trituration with water, is restored to its original form of milk-juice or emulsion. The official Almond Emulsion is a good example.

Associated with resin and sometimes with ethereal oil, the milk-juice of many plants exudes and dries into semi-solid masses or tears. Examples of these we have in the Gum-Resins, Ammoniac and Asafœtida, which furnish official emulsions by beating them in a mortar with Water.

The amount of gum contained in a Gum-Resin is not always sufficient to emulsify the other constituents, resin and ethereal oil, and it is then necessary to add gum *artificially* in order to produce complete emulsification.

These natural products are the most perfect emulsions, and to simulate them is the object of pharmacal art. A natural emulsion may be greatly diluted with water without causing separation of the oil. This is the best test to indicate that an emulsion is *perfect*.

#### ARTIFICIAL EMULSIONS.

These are made by mixing the Oil with a certain proportion of the emulsifying agent, adding Water and trituration of the mixture in a Mortar or agitation in a Flask.

There are various methods, but these are general rules:

The emulsification of the oil should be *complete* before the mixture is made up to the required measure.

When Alcoholic liquids are to be added, they should first be *diluted* as much as possible.

Salts should be *dissolved* before being added.

No heat should be employed, as the oil *separates* in an emulsion when heated.

Emulsions should be *freshly* prepared and be preserved in a *cold* place.

The most common Emulsifying Agents, in the order of their general value, are:

Powdered Gum Acacia: with the powdered Gum, contained in a capacious flat-bottomed, wedgewood mortar, the oil is gradually incorporated. To this *one and a half times as much* Water as of Gum is added *at once* and the mixture rapidly triturated with a rotary motion of the pestle. Soon the mixture becomes stiff and assumes a milk-white color, the pestle-mortar producing a characteristic "crackling" sound, when the emulsification is complete. This so-called "mother-

emulsion" may now be diluted to the required measure and other substances, flavors, etc., be added.

The proportion of Gum required varies with different Oils, an oil rich in gum, such as Castor Oil, requiring less gum than an oil poor in natural gum, as Cod Liver Oil.

The following proportions hardly ever fail to produce complete emulsification: Gum, 2 parts; oil, 4 parts; water, 3 parts.

Whenever a lesser proportion of Gum is used the water must be decreased in proportion, viz.: One and a half times as much water as of gum employed.

The Ethereal or Volatile Oils require a much larger proportion of Gum than the fixed oils.

Powdered Tragacanth may be used in the same way, or in the form of mucilage, but it does not produce as permanent emulsions as does gum acacia.

Mucilage of Acacia or of Irish Moss (N. F.).—These are not as satisfactory as powdered gum; while they produce good emulsions the division of the oil-globules is not as thorough as in the preceding; emulsification being incomplete, the mixture more rapidly separates into a heavier, watery liquid and a lighter, thick gelatinous emulsion, which requires thorough mixing before use.

Extract of Malt is an excellent emulsifying agent, when its use is admissible. The oil should be added to the Malt Extract, contained in a capacious mortar and incorporated in small quantities at the time. A good article will emulsify an equal volume of Cod Liver Oil.

Condensed Milk and Egg-yolk produce the most perfect emulsions and also the most palatable, but they rapidly ferment and spoil.

Glycerin and sugar added to emulsions for the purpose of preservation and palatability induce separation and their use is not advisable.

Emulsification "by intervention" is the best and only reliable method to be employed with Ethereal Oils and all substances of themselves not emulsifiable. It is illustrated in the official Chloroform Emulsion.

Oil of Turpentine, for example, is emulsified by dissolving the Turpentine Oil in twice its volume of a bland fixed oil (Almond Oil), incorporating an equal weight of powdered Acacia, adding Water and proceeding as with an ordinary emulsion.

Pancreatin emulsifies fats in preparing them for digestion, but it does not produce a permanent emulsion when used artificially. While, therefore, not a reliable emulsifying agent, it aids the assimilation of oils and its addition to emulsions is sometimes therapeutically desirable. As it is only active in alkaline media the Emulsion should be prepared with a little Sodium Bicarbonate.

The addition of Alkalies to emulsions should be avoided. Soaps are not Emulsions; neither is the use of Soap-Bark to be recommended.

The four official Emulsions may be classified as follows:

## Natural Emulsions:

From Gum resin triturated with water:	% vol.
Emulsum Ammoniaci . . . . .	ammoniac 4.
Emulsum Asafetidæ . . . . .	asafetida, in select tears 4.
From seed by intervention:	
Emulsum Amygdalæ . . . . .	sugar 3, acacia powd. 1. sweet almond 6.

## Artificial emulsion by intervention:

Emulsum Chloroformi . . . tragacanth powd. 1.5, chlor. 4.  
expressed oil almond 6, water, to 100.

Shake Chloroform and tragacanth together in a dry bottle, incorporate 25 c.c. Water, then the Almond oil, in small quantities, and finally in the same way add the remainder of the Water.

## LINIMENTS—LINIMENTA.

The Liniments are liquid preparations for external use consisting of solutions of *oily* or *resinous* constituents in Alcohol or Oils; or mixtures of liquid Soaps. The nine official are prepared:

By solution;

Linimentum:	% by vol.
Belladonnæ . . . . . fl. ext. belladonna 95, camphor	5.
Chloroformi . . . . . soap liniment 70, chloroform	30.
Saponis Mollis . . . alcohol 30, lavender oil 2, soft soap	65.
Sinapis Comp. . . . fl. ext. mezereum 20, mustard oil vol.	3.
	camphor 6, castor oil 15, alcohol, to 100.

By solution with heat:

## Terebinthinæ.

By saponification:  
 Linimentum: % by vol.  
     Ammoniæ . . . cotton-seed oil 60, alcohol 5, ammonia water 35.  
     Calcis . . . . . linseed oil 50, lime solution 50.

## Products by Extraction.

The preparations made by extraction are represented by ten classes of which seven are liquid, one semi-solid, the Extracts; one solid, the Resins, and one semi-liquid, the Oleoresins.

With reference to the Menstrua, they are divided into aqueous, acetous, vinous, alcoholic and ethereal preparations.

The aqueous include the Mucilages, Infusions and Decoctions.

## MUCILAGES—MUCILAGINES.

These are made by extracting the soluble principles of *mucilaginous* Drugs with Water.

When made from Gums completely soluble they may be classed as solutions. They are made by dissolving the substance in water and rejecting undissolved matter by straining:

### Mucilago (gen.-inis):

% by w.t.  
or vol.

Tragacanthæ (glycerin 18) tragacanth . . . . . 6.

Sassafrasæ Medull . . . . . sassafras pith 2.

By digestion:

Mucilago Ulmi . . . . . slippery elm bark 6.

## INFUSIONS—INFUSA

Unless otherwise directed to be prepared by the general process:

Of the Drug coarsely comminuted 5 Gm. Boiling Water 100 c.c.

Pour the Boiling Water on the Drug in a suitable vessel, provided with a cover, and let it stand for half an hour, strain and add enough Water through the strainer to make 100 G. C.

*Caution.*—The strength of Infusions of powerful drugs, i. e. Ipecac, should be especially prescribed.

The following Infusions are official, being prepared by different strengths and by other processes than directed in the general process:

### Infusum:

Digitalis . . digitalis 1.5; alcohol 10; cinnamon water 15;	water to make	100
Sennæ Comp. (Black Draught) . . senna (fennel 2) 6; manna. mag. sulph., of each 12, water to make		100

## By Percolation without Heat.

	<i>% by vol.</i>
Infusum Cinchonæ . . . . . acid arom. sulph. 1, cinchona	6.
Pruni Virginianæ . . . . . wild cherry	4.

## DECOCTONS—DECOCTA.

Unless otherwise directed Decoctions are prepared according to the following general process:

Of the drug coarsely comminuted . . . . .	5 Gm.
Boiling water to . . . . .	100 c.c.

Pour the Cold Water on the Drug, contained in a suitable vessel provided with a cover, bring it to a boil and let it boil for 15 minutes. Let it cool to 40 C. (104 F.), express, strain and add cold water through the strainer to make 100 c.c.

Caution as with infusions.

The following Decoctions are official, as being made of different strengths and methods than directed in the general process:

Decoctum:	<i>% by vol.</i>
Cetrariae . . . . . Iceland moss	5.
Sarsaparillæ Comp. . . . . mezereum 1, sarsaparilla glycyrrhiza, sassafras, guaiac wood, of each	10.

The Cetraria is macerated with cold water for half an hour and the expressed liquid rejected before it is boiled with the water. In the Sarsaparilla Decoction, the Sarsaparilla and Guaiac wood are boiled separately for half an hour, and then the other drugs are macerated in the mixture for two hours before it is strained.

## VINEGARS—ACETA.

The Vinegars are made by extraction with Dilute Acetic Acid.

By maceration:

Acetum:	<i>% by vol.</i>
Opii (Black Drop) . . . . . sugar 20, nutmeg 3, opium	10.
Scillæ . . . . . squill	10.

The Vinegars of Lobelia and Sanguinaria (80) were of the same strength.

## WINES—VINA.

The Wines are made by solution, by maceration or by maceration and percolation. The Menstrua is White Wine to which from 10 to 15 per cent of Alcohol is added to aid in the extraction and in the preservation. There are ten Wines official.

Those made by solution:

Vinum:	<i>Parts.</i>
Antimonii . . . . . antimony, potass. tart. (sol. water)	0.4
Ferri Amarum . . . . . iron, quinine citrate, soluble (Bitter Wine of Iron) tinct. orange peel 15, syrup	5. 30.

Vinum Ferri Citratis . . . . .	iron ammonium citrate	4.
	tinct. orange peel 15, syrup 10, wine to	100.
Ipecacuanhae . . . . .	alcohol 10, fl. ext. ipecac	10.
By maceration:		
Vinum Opii . . . . .	cinnamon, cloves, each 1, opium	10.
By maceration and percolation:		
Vinum Colchici Radicis . . . . .	colchicum root	40.
" Colchiei Seminis . . . . .	" seed	15.
" Ergotae . . . . .	ergot	15.

The Natural Wines: Vinum Album and Vinum Rubrum are described under "Products by Fermentation."

### TINCTURES—TINCTURÆ

The Tinctures are liquid preparations made by the extraction of Drugs with menstrua of Alcohol and Water in various proportions.

They are prepared by maceration and filtration; also by percolation and a few by solution:

By *maceration* and *filtration*, those containing resins and oleoresins, Musk, and tinctures of fresh herbs; in a few instances with heat, the Tinctures of Opium, Tincture of Quillaja and Tincture Strophanthus.

By *percolation*, when prepared from dried vegetable drugs, i. e., barks, leaves, roots, etc., usually after brief maceration.

By *solution*, mixing a solution (chloride iron), or dissolving a solid in alcohol (iodine, ext. nux vomica).

Tinctures are the simplest form of alcoholic products by extraction. From a Tincture all the other preparations may be *progressively* produced, through concentration by evaporation, as follows:

*Fluid Extract* representing a uniform drug-strength, viz.: 1 Gram in 1 c.c.

*Extract* or "solid extract," a semi-solid mass of pilular consistence of no uniform drug-strength; or assayed and powdered with diluent, to represent a certain alkaloidal strength (Opium, Nux Vomica).

*Abstract* or "powdered extract" by incorporation of Sugar of Milk with the extract to represent one-half the weight, or twice the strength of the drug.

*Resins*, separation of the resinous constituents, by precipitation in Water, of a concentrated alcoholic Tincture.

The Tinctures range in strength (excluding the compound tinctures) from 5 to 50 per cent. They are all made *by volume*.

SYLLABUS OF THE OFFICIAL TINCTURES.		Menstrua for 100 c.c., or vol. %.		
	Part of Plant or Drug.	Water	Alco- hol.	
<i>Containing 5 per cent.—</i>				
Tinctura Cantharidis .....	insect .....	.....	100	
" Capsici .....	fruit .....	5	95	
" Moschi .....	secretion. ....	50	50	-
" Strophanthi .....	seed .....	35	65	
<i>Containing 7 per cent.—</i>				
Tinctura Iodi .....	non-met. ....		100	
<i>Containing 10 per cent.—</i>				
Tinctura Arnicæ Radicis .....	root .....	35	65	
" Bryoniae .....	" .....	..	100	
" Calumbæ .....	" .....	40	60	
" Cardamomi .....	fruit .....	50	50	
" Chiratæ .....	herb .....	35	65	
" Cinnamomi (zeyl). ....	bark .....	20	75	Glyc. 5.
" Croci .....	stigma .....	50	50	
" Kino .....	insp. juice .....	20	65	Glyc. 15.
" Matico .....	leaves .....	50	50	
" Opii (see note) .....	insp. juice .....	50	50	
" Opii deod " .....	" .....	80	20	
" Quassiae .....	wood .....	65	35	
" Rhei (cardamom 2) .....	root .....	30	60	Glyc. 10.
" Serpentariae .....	rhizome .....	35	65	
" Sumbul .....	root .....	35	65	
" Tolutana .....	balsam .....		100	
" Vanillæ .....	fruit .....	35	65	Sugar 20.
<i>Containing 15 per cent.—</i>				
Tinctura Belladonnæ .....	leaves .....	50	50	
" Cannabis Indicæ .....	herb .....	100		
" Colchici .....	seed .....	40	60	
" Digitalis .....	herb .....	50	50	
" Gelsemii .....	rhiz. ....	35	65	
" Hyoscyami .....	leaves .....	50	50	
" Physostigmatis .....	seed .....		100	
" Sanguinariae .....	rhiz. ....	40	60	Ac. Acet 2.
" Scillæ .....	bulb .....	25	75	
" Stramonii Seminis .....	seed .....	50	50	

*Assayed Tinctures.*—Two of the most important Tinctures are required to be of certain specified alkaloidal strengths and their classification according to their respective drug-strengths is therefore only approximately correct.

*Tinctura Opii.*—Should be so adjusted as to represent from 1.3 to 1.5 per cent of crystallized morphine, the proportion obtained from 10 per cent of Opii pulvis, U. S.

*Tinctura Nucis Vomicæ.*—Made by solution of 2 per cent of the official Extract, representing about ten times its weight of the drug; the Tincture, therefore, being in the 20 per cent class. The Tincture contains 0.3 per cent total alkaloids. (See Alkaloids.)

SYLLABUS OF TINCTURES (CONTINUED).		Menstrua for 100 Parts by vol.		
	Part of Plant or Drug.	Water	Alco- hol.	
<i>Containing 20 per cent.—</i>				
Tinctura Arnicæ Florum.....	flowers	50	50	
" Asafœtidae.....	gum-resin	.....	100	
" Aurantii Amari,.....	rind	40	60	
" Aurantii Dulcis,.....	"	.....	100	
" Benzoini,.....	bals-resin	.....	100	
" Calendulae.....	herb	.....	100	
" Cimicifugæ.....	rhizome	.....	100	
" Cinchonæ.....	bark	25	67.5	Glyc. 7.5.
" Cubebæ .....	fruit	.....	100	
" Gallicæ .....	excresc.	.....	90	Glyc. 10.
" Guaiaci.....	resin	.....	100	
" Guaiaci Ammon.....	"	.....	.....	sp. am. ar.
" Humuli,.....	strobiles	50	50	
" Hydrastis,.....	rhizome	50	50	
" Krameriae,.....	root	50	50	
" Lobeliae .....	herb	50	50	
" Myrrhae .....	gum-resin	.....	100	
" Nucis Vomicæ (see note)	seed	25	75	
" Pyrethri,.....	root	.....	100	
" Quillajæ,.....	bark	60	40	
" Valerianæ .....	rhizome	25	75	
" Valerianæ Ammon.....	"	.....	.....	sp. am. ar.
" Zingiberis .....	"	.....	100	
<i>Containing 25 per cent.—</i>				
Tinctura Ferri Chloridi.....	solution		75	
<i>Containing 35 per cent.—</i>				
Tinctura Aconiti,.....	tuber	30	70	
<i>Containing 40 per cent.—</i>				
Tinctura Veratri Viridis.....	rhizome		100	
<i>Containing 50 per cent.—</i>				
Tinctura Lactucariai .....	resin	25	50	Glyc. 25.

Tincturae Herbarum Recentium—Tinctures of Fresh Herbs, or "Green Tinctures."

When not otherwise directed to be prepared by the following General Formula:

Take of the fresh herb, bruised or crushed, 50 Gm.; macerate for 14 days in Alcohol 100 c.c.; express the liquid and filter.

Compound tinctures (showing parts of drug in 100).	Water	Alco.	Glyc.
<b>Tinctura:</b>			
Aloes .....	{ aloes ..... 10. licorice root.... 20.	50	50
Aloes et Myrrhæ.....	{ aloes..... 10. myrrh..... 10. licorice root.... 10.	25	75
Benzoini Comp.....	{ aloes 2, benzoin.. 12. storax 8, tolu.... 4.	.....	100
Cardamomi Comp . . .	{ cardamom ..... 2. cinnamon..... 2. cara'y 1, cochin'l. 0.5	50	50
Catechu Comp.....	{ catechu ..... 10. cinnamon..... 5.	50	50
Cinchonæ Comp.....	{ red cinchona.... 10. bitter orange.... 8. serpentaria..... 2.	7.50	85
Gentianæ Comp.....	{ gentian ..... 10. bitter orange.... 4. cardam ..... 1.	40	60
Ipecacuanhæ et Opii.....	{ tinct. opii deod... 100. fl. ext. ipecac.... 10. oil lavend..... 0.8 oil rosmar..... 0.2	.....	ev.q.s. 100
Lavandulae Comp.....	{ cinnamonom..... 2. nutmeg ..... 1. red saunders.... 1. cloves ..... 0.5	27	73
Opii Camphorata.....	{ opium p..... 0.4 acid benzoic.... 0.4 camphor..... 0.4 oil anise..... 0.4	48	48
Rhei Aromatica .....	{ rhubarb ..... 20. cinnam ..... 4. cloves ..... 4. nutmeg ..... 2.	40	50
Rhei Dulcis.....	{ rhubarb ..... 10. glycyrrh..... 4. anise..... 4. cardamom ..... 1.	40	50

### FLUID EXTRACTS—EXTRACTA FLUIDA.

Fluid extracts may be defined as a class of concentrated tinctures of such strength as to represent the drug *volume for weight*.

The fluid extracts of the U. S. Ph., previous to 1880, represented one grain of drug in one minim, or one troy ounce in one fluid ounce. In the U. S. Ph., 1880, the standard adopted was *one Gram* in *one cubic centimeter*, and this strength has been retained as the standard for the U. S. Ph., 1890.

Fluid extracts are made by *percolation*, *maceration* or *digestion* and

*expression.* Except on a large scale, or by *fractional percolation*, they cannot be prepared by simple percolation without evaporation to concentrate the percolate to the required measure.

Fractional or repercolation, or simultaneous fractional percolation, by employment of which the use of heat for concentrating the percolate is avoided, may be used to advantage, when the quantity operated upon is sufficiently large to warrant the greater time and attention required.

The following are the processes employed:

A. In proceeding to percolate one hundred Grams of the drug, according to directions, the first 80 to 90 cubic centimeters are reserved, and percolation continued until the exhaustion is completed. The weak percolate is evaporated to a soft extract (the alcohol being recovered) and dissolved in the reserved percolate. Sufficient of the menstruum is then added to make the product measure 100 c.c.

The official proportions for menstrua expressed in percentages by volume (cubic centimeters), are given in the subjoined tables:

MENSTRA—ALCOHOL (94 PER CENT BY VOLUME.)

Extractum Fluidum.	Drug.	Extractum Fluidum.	Drug.
Aromaticum.....	aromatic powder.	Gelsemii.....	root.
Buchu .....	leaves.	Grindelæ.....	herb.
Calami .....	root.	Iridis .....	rhizome.
Cannabis Ind.....	herb.	Lupulini .....	glands.
Capsici .....	fruit.	Mezerii.....	bark.
Cimicifugæ .....	root.	Sabinæ .....	tops.
Cubebæ.....	berry.	Veratri Viridis.....	rhizome.
Cusso .....	flores'nce	Xanthoxyli.....	bark.
		Zingiberis .....	rhizome.

MENSTRA—ALCOHOL 80; WATER 20, IN 100 C.C.

Extractum Fluidum.	Drug.	Extractum Fluidum.	Drug.
Belladonnæ.....	root.	Rhei .....	root.
Eriodictyi .....	herb.	Serpentariae .....	rhizome.
Podophylli.....	rhizome.		

MENSTRA—ALCOHOL 75; WATER 25.

Extractum Fluidum.	Drug.	Extractum Fluidum.	Drug.
Arnicæ .....	root.	Leptandracæ.....	rhizome.
Aconiti .....	root.	Matico .....	leaves.
Calumbæ.....	root.	Scillæ .....	bulb.
Eucalypti.....	leaves.	Valerianæ .....	rhizome.
Guaranæ.....	seed	Viburni Opuli.....	bark.
Ipecacuanhae.....	root.	Viburni Prunifolii.....	bark.
		Stramonii .....	seed.

MENSTRA—ALCOHOL 67; WATER 33.

Extractum Fluidum.	Drug.	Extractum Fluidum.	Drug.
Aurantii Amari.....	rind.	Digitalis .....	leaf.
Chiratæ .....	herb.	Hyoscyami.....	leaf.
Colchici Radicis.....	corm.	Menispermi.....	rhizome.
Colchici Seminis.....	seed.	Phytolaccæ .....	root.

## MENSTRA DILUTED ALCOHOL; ALCOHOL 50; WATER 50, IN 100 C.C.

Extractum Fluidum.	Drug.	Extractum Fluidum.	Drug.
Asclepiadis .....	root.	Pilocarpi .....	leaves.
Chimaphilæ .....	herb.	Rumicis .....	root.
Cocæ .....	leaf.	Spigeliae .....	rhizome.
Convallariæ .....	rhizome.	Stillingiae .....	root.
Cypripedii .....	rhizome.	Lappæ .....	root.
Dulcamarae .....	twigs.	Rhamni Purshianæ .....	bark.
Eupatorii .....	herb.	Scoparii .....	tops.
Gentianæ .....	root.	Scutellariæ .....	herb.
Lobeliae .....	herb.	Sennæ .....	leaves.
		Taraxaci .....	root.

## MENSTRA—ALCOHOL 38; WATER 62.

Extractum Frangulæ Fluid..bark.

## MENSTRA—ALCOHOL 33; WATER 67.

Extractum Quassiae Fluid..wood.

Sarsaparillæ ..... root. |

## MENSTRA, ALCOHOL AND GLYCERIN.

Extractum Fluidum.	Drug.	Glyc. in 100 c.c.
Cinchonæ .....	bark.....	20
Gossypii radicis.....	root bark.....	25

## DILUTED ALCOHOL AND GLYCERIN.

Extractum Fluidum.	Drug.	Glyc. in 100 c.c.
Geranii .....	rhizome .....	10
Krameriae .....	root.....	20
Rhois Glabræ.....	leaves.....	10
Rosæ .....	leaves.....	10

MENSTRA—ALCOHOL, WATER AND GLYCERIN IN VARIOUS PROPORTIONS.	DRUG.	MENSTRA IN 100 CC.		
		Alco.	Water	Glyc.
Extractum Fluidum				
Apocyni .....	root.	65	25	10
Aspidospermatis .....	bark.	60	30	10
Hamamelidis.....	leaves	35	55	10
Hydrastis .....	rhiz.	60	30	10
Pareiræ.....	root.	72	18	10
Rubi .....	r't b'k.	60	30	10
Sarsaparillæ Comp.....	Sarsaparilla 75 glycyrrhiza 12, sassafras 10, mezereum 3	30	60	10
Uvæ Ursi.....	leaves	20	50	30
Menstruum: (1) Water 30 c.c., Glycerin 10 c.c.; (2) Alcohol 85 c.c., Water 15 c.c. ....				
Extractum Pruni Virginianæ Fluidum.....	bark.	50	40	10

B. In some drugs, the active principles are extracted with difficulty or liable to dissociation by the heat employed in the evaporation of the weak percolate. In such cases an *acid* is added to the menstrua which combines with the alkaloid and forms salts much more soluble and not so readily volatilized. To this class belong:

EXTRACTUM FLUIDUM.	DRUG.	MENSTRUA IN 100 C.C.		
		Alco.	Water.	Acid Acet.
Conii . . . . .	fruit	75	25	2
Ergotæ . . . . .	sclerot.	50	50	2
Nucis Vomicæ <sup>1</sup> . . . . .	seed.	75	25	5
Sanguinariae . . . . .	rhiz.	75	25	5

C. When the active principles are of acid character and extracted with difficulty by the use of ordinary solvents (neutral menstrua) or are liable to gelatinize, alkaline menstrua are employed for their extraction.

Two of this class are official:

EXTRACTUM FLUIDUM.	DRUG.	MENSTRUA IN 100 C.C.		
		Alco.	Water	Amon. Water
Glycyrrhizæ . . . . .	root.	30	65	5
Senegæ . . . . .	root.	75	20	5

D. When the active principles are readily soluble in water and the drug is very cellular, extraction is effected by digestion and expression. This method must be applied only to drugs whose principles are not impaired by the heat necessary to concentrate the expressed liquid to the required measure.

To exhaust drugs with water, maceration and expression are always necessary, because the cell-walls swell, and the water acts upon starch and gummy matter, thus impeding the flow in percolation. A greater proportion of solvent is also necessary than in the process of percolation, hence the necessity for the evaporation of the liquid extract. Since water, especially when hot, extracts matter causing fermentation, the liquid is evaporated to about twice the bulk of the drug employed and Alcohol added so that the liquid may contain about 25 per cent of alcohol by which the undesirable principles are precipitated. The easily fermentable substances are insoluble in liquids containing 20 per cent, or above, of alcohol, and are precipitated and freed from the extract by filtration. The alcohol also acts as a preservative, since aqueous solutions of vegetable substances do not keep for any length of time.

Two of this class are official:

Extractum Castaneæ Fluidum . . . . .	glycerin 10, leaves
" Tritici Fluidum . . . . .	rhizome
Extractum Ergotæ Purificatum or "liquid ergot,"	Ergotin, and
Extractum Sennæ Fluid.	Aquosum may be prepared by this process.

<sup>1</sup>The concentration is adjusted so that the Fluid Extract shall contain 1.5 per cent of total alkaloids and that 10 c.c. shall represent 1 Gm. extract nux vomica.

## EXTRACTS—EXTRACTA.

Extracts, or "solid" extracts as they are termed, to distinguish them from fluid extracts, are the soluble active principles of vegetable drugs, concentrated by evaporation to a soft solid, or a plastic mass of pilular consistence.

The *strength* of an extract depends upon the amount of the crude drug it represents. Hence, the *smaller* the percentage of extract obtained from a drug, the *greater* the relative strength of the extract; provided that the drug is exhausted with menstrua adapted to secure all the active principles in this form.

Thus the extracts of different drugs are as many times stronger than the drug as the quotient obtained by dividing the drug at 100 by the percentage yield. For example: Podophyllum yields 10 per cent of extract; then  $100 \div 10 = 10$ , that is, the extract is ten times as strong as the drug and the Fluid Extract, or that 0.1 of the extract represents 1 Gm. of the Drug or 1 c.c. of the Fluid Extract.

The yield of extract is influenced by the character of the menstrua employed; with a few drugs like Rhubarb the quality of the drug sometimes governs the yield, the least percentage being obtained from the poorest quality.

As a general rule, the more *aqueous* the menstrua the *greater* the yield of extract; conversely, the more *alcoholic* the menstrua the *smaller* the yield of extract. To obtain the extracts, therefore, of official *strength* it is necessary to use official *menstrua* in the extraction.

The 33 official extracts may be divided into four classes:

1. Those made by extraction with Alcoholic menstrua, by percolation and concentration to pilular consistence, including those made by addition of acid (Conium) and evaporation from Fluid Extract (Ergot).

2. By extraction with Water, hot or cold infusion, digestion or contusion of fresh drug, and concentration to pilular consistence, including one each made by:

Addition of *acid* (Colchicum), of *Alkali* (Glycyrrhiza, pure) and Extract Glycyrrhiza, commercial, not prepared in the retail pharmacy.

3. Powdered Extracts, Colocynth, and those made by addition of powders to the extracts including:

4. *Assayed Extracts* of Nux Vomica and Opium and One Compound Extract, of Colocynth.

The drug strength of these and their respective doses estimated on their drug strengths may be presented as follows:

EXTRACTUM.	Menstrua 100 c.c.		Yield.	Parts of Drug in 1 of Ex- tract.	Dose of Drug. Grains.	Dose of Ex- tract. Grains.
	Alco- hol.	Water				
Aconiti (rad).....	100	.....	20	5	1	$\frac{1}{5}$
Arnicæ .....	50	50	20	5	.....	.....
Belladonnæ Fol. Alcoholic .....	67	33	20	5	3	$\frac{1}{2}$
Cannabis Indicæ .....	100	.....	10	10	10	1
Cimicifugæ .....	100	.....	10	10	10	1
Cinchonæ .....	75	25	16	6	30	5
Conii (ac. acetic 2).....	50	50	25	4	4	1
Digitalis .....	67	33	25	4	2	$\frac{1}{2}$
Ergotæ .....	from Fl. Ex		20	5	30	6
Euonymi.....	67	33	20	5	30	6
Hyoscyami .....	67	33	17	6	3	$\frac{1}{2}$
Iridis.....	100	.....	14	7	7	1
Jalapæ.....	100	.....	15	6	6	1
Juglandis .....	50	50	15	6	6	1
Leptandrae .....	75	25	18	5 $\frac{1}{2}$	10	2
Physostigmatis .....	100	.....	2.5	40	5	$\frac{1}{5}$
Podophylli .....	80	20	10	10	10	1
Rhei.....	80	20	35	3	30	10
Stramonii (seed).....	50	50	15	6	3	$\frac{1}{2}$
Uvae Ursi.....	30	75	30	3	30	10

The number of Grams of Drug represented by 1 Gm. of Extract corresponds equally to the number of grains of Drug represented by 1 grain of the extract and the proportion is the same in any other denomination of weights.

#### By extraction with Water:

EXTRACTUM.	% Yield.	Parts of Drug in 1 of Ex- tract.		Dose of Drug. Grains.	Dose of Ex- tract. Grains.
		Gm.	Grains.		
<u>By hot infusion:</u>					
Aloes (aquosa).....	50	2	10	5	.....
<u>By infusion, coagulation by boiling:</u>					
Gentianæ .....	25	4	20	5	.....
Hæmatoxylı.....	25	4	10	2 $\frac{1}{2}$	.....
Krameriae .....	20	5	10	2	.....
Quassiae .....	2.5	40	5	$\frac{1}{5}$	.....
<u>By percolation with Dilute Acetic Acid:</u>					
Colchici.....	35	3	5	2	.....
<u>By percolation with Amon. Water:</u>					
Glycyrrhizæ, pur.....	40	2 $\frac{1}{2}$	30	12	.....
<u>By insuccation from fresh drug:</u>					
Taraxaci.....	30	3	30	10	.....
<u>Powdered extracts:</u>					
<u>By extraction with Dilute Alcohol:</u>					
Extractum Colocynthidis .....	17	6	3	$\frac{1}{2}$	.....

By incorporation with other substances:	<i>In 100.</i>
Extractum Colocynthidis Compositum . . . . ext. colocynth	16
aloes, purif 50, scammony resin, soap powd., each 14	
cardamom 6, alcohol to 100	

To the Aloes, fused on a water-bath, the Alcohol is added, then the Soap, Colocynth Extract and Scammony Resin; heat until the mixture becomes brittle upon cooling; thoroughly incorporate the Cardamom, allow the mixture to become cold and then reduce it to powder.

*Assayed Extracts.*—By extraction, concentration by evaporation and addition of Sugar of Milk to represent a certain alkaloidal strength in the powdered extract:

By Percolation with alcohol 75, water 25, acid. acetic 5.

Extractum Nucis Vomicæ—contains 15 per cent of total alkaloids,  
1 represents about 10 of drug.

By extraction with water.

Extractum Opii—contains 18 per cent of crystallized morphine;  
1 represents 2 of normal moist opium, about one and a half of  
Opii pulvis.

The preparation of these, the processes of assay and their strengths related to their respective Drugs, have been described under the Alkaloidal Drugs in the preceding Lecture.

#### ABSTRACTS—ABSTRACTA.

A class of powdered extracts, prepared from the extracts by the addition of sufficient milk sugar to make the product represent one-half its weight of the crude drug, was official in the U. S. Ph. 1880, under the title of Abstracts.

The Abstracts have a uniform relation to the drug, viz: *One grain represents two grains of the drug*, just as the fluid extracts have the uniform relation of representing the drug *measure for weight*.

In preparing an abstract the drug is exhausted with proper menstruum and the extract obtained; this, while yet warm, is incorporated with its weight of milk sugar (powdered) and set in a warm place. When sufficiently dry the mixture is powdered and enough milk sugar added to bring the product to one-half the weight of the drug employed. Abstracts must be preserved in small, perfectly dry and well-corked vials in a dry and cool place.

Their uniformity alone should have favored the employment of Abstracts in preference to the Extracts, since they do not share the variability in strength of the extracts, the dose of the Abstract being exactly one-half that of the crude drug or Fluid Extract. Unfortunately this advantage on the other hand, was offset by the disadvantage that Abstracts are more bulky, and caused their deletion in the U. S. Ph. '90.

The official Extracts of Jalap and of Nux Vomica have superseded the Abstracts of these respective drugs in a more concentrated and equally convenient form. Of the remaining nine Abstracts formerly official Aconite, Belladonna, Conium, Digitalis, Hyoscyamus (Ignatia, superseded by Nux Vomica), Podophyllum, Senega and Valerian, the five first mentioned, commonly but

incorrectly called the "narcotics," may be made of a strength to represent *four times the weight* of the respective drugs, or nearly the same strength as the official Extracts, by extraction with a menstruum of Alcohol 75, Chloroform 25 vols.

There is no need of the Abstract of Senega nor of that of Podophyllum, the resin taking its place. The volatile oil in Valerian does not permit of evaporation necessary for the preparation of an extract but the Abstract is an ideal form and the most concentrated preparation of Valerian practicable.

### OLEORESINS.—OLEORESINÆ.

The *pharmaceutical* Oleoresins are semi-liquid extracts, obtained by exhausting Oleoresinous drugs with Ether. The *natural* Oleoresins have been considered.

Ether extracts *fixed* and *volatile oils* from drugs, as well as *resin*; these principles constitute therefore the oleoresins which sometimes also contain other active matter in solution or suspension.

The menstruum (ether) being easily volatilized, is recovered by distillation; it is sometimes superseded by alcohol, which yields an extract very similar to that obtained with ether.

The six following are official:

Oleoresina Aspidii separates in two layers, to be mixed when used.

- " Capsici—separates fat.
- " Cubebæ— " wax.
- " Lupulinæ
- " Piperis—separates piperine, to be rejected.
- " Zingiberis.

### RESINS.—RESINÆ.

The official Resins may be divided into the (1) Natural Resins, (2) Resins obtained from Oleoresins by separating the Volatile Oil by distillation and (3) the Pharmaceutical Resins, prepared by *precipitation*.

When a concentrated tincture of a resinous drug is poured into a large quantity of cold water the resinous matter becomes insoluble and is precipitated; this, after being washed, dried and sometimes powdered, is termed a *resin*.

Resins are usually *soluble* in Alkalies and *insoluble* in Acids (dilute); for this reason the Water used for precipitation is sometimes rendered slightly acid to favor the separation.

The three following are official:

Resina Jalapæ—precipitated in water; yield 15 %, 1 rep. 6 of Drug.

" Scammonii " " " 80 %.

" Podophylli " in acidulated water; yield 5 %, 1 rep. 20 of Drug.

The Resins obtained as by-products in the distillation of oils:

Resina and Resina Copaibæ and the Natural Resins have previously been described.

The terms *resin*, *resinoid* and *concentration* are also applied to a class of preparations used by eclectic physicians, prepared by this general process with some modifications. (See U. S. and Am. Disp.)

They are named after their respective Drugs with the ending *in* as in the Glucosides and must not be confused with the latter. While the Glucosides are usually the active medicinal constituents representing the drug, the resinoids being only the *resinous* constituents represent the value of such drugs only, whose chief constituents are resins, or whose medicinal value depends upon resins.

## Mixtures of Solids.

This division embraces the several classes of preparations consisting of Mixtures of Solids in various *forms*.

As their therapeutic uses govern their pharmaceutical form, they may be divided into those (1) for internal use and those (2) for external use. The first group includes the Powders, Triturations, Confections, Troches, Masses and Pills.

These are treated according to the *progressive system*, illustrative of the successive methods by which the various preparations may be made from each other, i. e., from the lowest forms, *powder*, to the highest, *pills*.

From a *powder* the other preparations may be made as follows:

Trituration, by trituration with a diluent as Sugar of Milk.

*Confection*, by making a mass from the powder with Sugar, etc.

*Troches*, by cutting a mass like a Confection containing gum and flavor into discs, to be slowly dissolved in the mouth.

*Mass*, by forming the powder into a plastic mass with Excipients.

*Pills*, by forming the mass into spherical bodies not to exceed 0.3 in weight, intended to be swallowed.

## POWDERS—PULVERES.

The nine official Powders are impalpable mixtures of one or more active drugs, usually with some nearly inert substance such as Sugar, as a *diluent*, and Aromatics.

They are made by trituration:

		<i>in 60 grs.</i>
Pulv. Morphinæ Compositus . .	camphor 19, morphine sulph. (Tulley's Powder)              calcium carb. precip., gly-	1.
	cyrrhiza p., each	20.
		<i>for 12 pow. in each, grs.</i>
Effervescens Compositus . .	potassium and	
(Seidlitz Powder)	sodium tartrate 93 gm.	120
	sodium bicarbonate 31 gm.	40
	acid tartaric 27 gm.	35

## CONFECTIONS—CONFECTIONES.

Confections may be defined as flavored masses wherein the adhesive substance is Sugar, in larger proportions, serving as a *vehicle* for masking the taste of the drug.

Confections, when made by beating a fresh drug, first reduced to pulp with sugar until of the proper consistence, are termed *conserves*. When made from powders or extracts they are called *electuaries*.

Only one representative of each class is official :

	<i>Gm. in 100.</i>
Confectio Rosæ . . . . .	rose water 16, red rose 8.
(Conserve of Rose)	sugar 64, honey 12.
Confectio Sennæ {	oil coriander 0.5, senna 10.
(Electuar. Sennæ) {	cassia fistula 16, fig 12, tamarind 10.
	prune 7, sugar 55, water to 100.

For details of manipulation, see U. S. Ph.

## MASSES—MASSÆ.

Masses are plastic mixtures of *pilular* consistence. They are made: (1) by incorporating the drug with adhesive substances; (2) by chemical reaction; (3) sometimes by both.

By the first process:

Massa Hydrargyri . .	glycyrrhiza 5, althæa 25, mercury 33.
Blue Mass)	glycerin 3, honey of rose 34.

By the second process:

Massa Copaiæ . . . . .	water 1, magnesia 6, copaiba 94.
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The Copaic acid combines with the magnesia, forming magnesium copaivate of pilular consistence.

By both these processes:

Massa Ferri Carbonatis {	sodium carb., ferrous sulph., each 100.
(Vallet's Mass) {	honey 38, sugar 25, syrup to 100.

By double decomposition between the Ferrous Sulphate and Sodium Carbonate, *ferrous carbonate* is formed, which is incorporated with Honey and Sugar to prevent oxidation, and to render the mixture a plastic mass.

## TROCHES—TROCHISCI.

Troches or *lozenges* are confections made into various forms and then dried.

The vehicle or excipient consists of powdered gum Tragacanth or Sugar with flavoring, in some cases orange flower water; in others, tolu, nutmeg, vanilla, etc.

The active ingredients are mixed with the diluent or vehicle and made into a plastic mass with the particular excipient, water, or syrup. The mass is rolled out to the requisite thickness and the disks formed by cutting through it with a *punch*, or troche-cutter. The troches are then dried by exposure.

The size and weight of the troche are regulated by the thickness of the mass and the diameter of the cutter.

The 15 official Troches vary in weight from Gm. 0.5 to 1.5:

	ACTIVE DRUG.		
<i>Trochisci:</i>	Gm. in 100 Troches.	In Each Troche.	
Acidi Tannici . . . . .	6.	0.06	orange flor.
Ammonii Chloridi . . . . .	10.	0.1	tolu.
	extract glycyrrhiza 25.	0.25	
Catechu . . . . .	6.	0.06	orange flor.
Cretæ . . . . .	25.	0.25	nutmeg.
Cubebæ . . . . . oleoresin	4.	0.04	tolu.
	extract glycyrrhiza 25.	0.25	
	sassafras oil 1.	0.01	
Ferri . . . . . ferric hydrate	30.	0.3	vanilla.
Glycyrrhizæ ext. glycyrrhiza	15.	0.15	anise.
et Opii powd. opium	0.5	mg.5.	.
Ipecacuanhæ . . . . .	2.	0.02	orange.
Krameriae . . . . . extract	6.	0.06	" flor.
Menthæ Piperitæ . . . . . oil	1.	0.01	peppermint.
Morphinæ . . . morphine sulph	0.16	mg.1 <sup>1</sup> / <sub>2</sub>	gaultheria.
et Ipecac. powd. ipecac	0.50	" 5.	
Potassii Chloratis . . . . .	30.	0.3	lemon.
Santonini . . . . .	3.	0.03	orange flor.
Sodii Bicarbonatis . . . . .	20.	0.2	nutmeg.
Zingiberis . . . tinct ginger	20.	0.2	ginger.

*Lozenges* of peppermint, lemon, musk, vanilla and gaultheria may readily be prepared by saturating sugar lozenges with the respective essences or tinctures and permitting the alcohol to volatilize.

## PILLS—PILULÆ.

Pills are spherical, more or less soluble, masses of medicinal substances rendered *cohesive*, *plastic* and *firm* in consistence by the addition of some substance (usually inert), termed *excipient*.

The *kind* of excipient employed varies with the nature of the medicinal substance. As a general rule such substances are chosen as give to the mass, with the smallest proportion, the greatest plasticity, and also best preserve the spherical shape of the pills. The excipient must also, unless the contrary be directed for especial purposes, be indifferent in character to avoid change in the medicinal agents.

Soluble Substances are rendered adhesive by the action of solvents and require the addition of some liquid that will act dissolving —water, alcohol, glycerin, etc., according to their solubilities. Others require the addition of adhesive substances, such as Syrup, Mucilage, Glucose, Glycerite Starch or Tragacanth, etc.

Drugs adapted for dispensing in the form of pills may be divided as follows:

## (1) The official Masses, Extracts and Scaled Salts.

Masses and extracts, being of pilular consistence, require no addition, except when hard, Water is incorporated to restore them to their original form. Abstracts and powdered extracts are best made into a mass with water.

## (2) Vegetable powders in which the dose does not exceed five grains.

With these *adhesive* excipients are indicated, such as Syrup, Mucilage, Glycerite Tragacanth and Glucose. The last mentioned answers the requirements better than most other substances. Confection of Rose and Extracts of Gentian, Glycyrrhiza and Taraxacum are also used, when their color is not objectionable.

## (3) Salts not too deliquescent and Alkaloids.

Excipients for these must combine *adhesive* and *absorbent* qualities. They are first triturated with a dry powder, *i. e.*, Althea, Glycyrrhiza or Milk Sugar, and then mixed with the adhesive substance, *viz.*: Glucose or Glycerite of Starch, or Tragacanth.

No excipient must be used that will give to the mass a color different from that of the medicinal ingredients (the base).

## (4) Volatile oils and oleoresins.

The quantity of these when dispensed in pills being comparatively large, it is necessary to add some light *absorbent* substance, such as Magnesia or Starch, to which is added the adhesive material. The practice of adding wax or resin to oils is not to be recommended except as a last resort, since they tend to render the pill insoluble.

## (5) Resins and gum-resins.

These form an adhesive mass by the addition of a little Alcohol, with which

more bulky excipients, such as Soap, may be incorporated to preserve the shape of the pill.

(6) Salts of the Cinchona Alkaloids, quinine and cinchonidine sulphates, etc.

These are often prescribed in pill-form in large doses, and it is therefore desirable to reduce their bulk. For this purpose dilute Sulphuric Acid or Tartaric Acid is added in small quantity, which acts dissolving upon the salt, thereby converting it into a mass. This mass is incorporated with a little Glycerite of Starch, otherwise it soon loses its plasticity, and must therefore be rolled into pills as soon as formed. Chinoidine acts the same way, although its bulk is not reduced.

(7) Substances easily decomposed by organic matter.

Potassium Permanganate and Silver Nitrate are quickly "reduced" when incorporated with the excipients usually employed.

These should be mixed with an inorganic diluent not affected by them, such as Kaolin, Pipe clay or Fuller's Earth and made into a mass with Water, Petrolatum, Resin Cerate, etc.

In *making* pills the following points are to be observed:

The substance, if a solid, must be reduced to a very fine powder, thoroughly mixed with a small quantity of the diluent or excipient; the remainder of the excipient is then incorporated.

The mass must be worked until it is perfectly homogeneous and of such consistence that it will scarcely adhere to the sides of the mortar, but form a coherent mass upon the pestle. A good pill mass is recognized by this quality, in which case the mortar employed will present an almost clean appearance when the mass is finished.

The *mortar* used for making pills should be a No. 2 or No. 3, with a bottom rather deep than flat; the pestle should not fit too closely, but its extreme end should be shaped somewhat differently from the shape of the bottom of the mortar.

In *rolling* the mass the cylinder must be of uniform diameter and even at the ends. When cut upon a pill machine, the cutter is placed lightly upon the cylindrical roll and moved to and fro with gradually increasing pressure, until the roll is divided and the pills formed. They may be rounded with a slab, or lid from a wooden ointment box, or some similar device, termed a pill-finisher.

*Dusting powder* is used for rolling the mass (to prevent it from sticking, for which powd. Glycyrrhiza is the best); also for dusting upon the pills to keep them separated from each other and to retain their shape; for this purpose Lycopodium is used except for white pills, which should be rolled in and dusted with Milk Sugar or Starch.

In pills *coated* with Sugar or Gelatin, such excipient is frequently employed as will prevent the mass from acting upon the coating—staining the pill. The

more soluble a pill the greater is the danger of discoloration of the coating, and although solubility should be the greatest desideratum, it is frequently sacrificed in coated pills for an elegant exterior. With some masses, staining of the coated pill cannot be avoided, no matter what excipient may be employed, in that event some insoluble substance, such as French Chalk or Starch, is spread upon the pills before the sugar coating is applied.

The following 15 Pills are official:

PILULÆ.	Gm. for 100	IN EACH.		Excipient.
		cg.	grains	
Aloes.....aloes purif., soap, each	13	13	2	water.
Aloes et Asafœtida.....aloes, asafœtida, soap, each	9	9	1½	"
Aloes et Ferri ..... aloes, iron sulf., arom.p.	7	7	1	conf. rose.
Aloes et Mastiches.....aloes (Dinner Pill) mastic	13	13	2	
	4	4	2/3	
	red rose	3	3	
Aloes et Myrrhæ ..... aloes myrrh	13	13	2	water.
	6	6	1	
	arom. powder	4	4	
Antimonii Comp.....antimony sulphurated	4	4	2/3	syrup.
(Plummer's Pills) mild mercurous chlor.	4	4	2/3	
	guaiac	8	8	
Asafœtida ..... asafœtida	20	20	3	castor oil.
Cathartic Comp....extract colocynth comp.	8	8	1½	soap.
mild mercurous chloride	6	6	1	
extract of jalap	3	3	½	
gamboge	1.5	1.5	¼	water.
Cathartic. Vegetabilis..ext. colocynth comp.	6	6	1	
exts. hyoscyam., jalap, each	3	3	½	
ext. leptandra, res. podophyll.	1.5	1.5	¼	
oil peppermint	0.8	0.8	⅛	water.
Ferri Carbonatis.....ferrous sulphate	16	6	1	
(Ferruginous, Chalybeate, potass. carb.	8			
Blaud's)....sugar, tragac., althea, each	1			glyc. water.
Ferri Iodidi <sup>1</sup> .....reduced iron	4	6	1	
	iodine	5		
	glycyrrh., sugar, each	4		
ext. glycyrrh., acacia, each	1			water.
Opii.....soap 2, opium pulv.	6.5	6.5	1	"
Phosphori <sup>2</sup> .....phosphori <sup>2</sup>	0.06	0.06	1/100	
	althea, acacia, each	6		glyc. water.
Rhei.....soap 6, rhubarb	20	20	3	water.
Rhei Comp.....rhubarb	13	13	2	
	aloes	10	10	
	myrrh	6	6	
	oil peppermint	0.5		"

<sup>1</sup>Coated with ethereal solution of Balsam Tolu.

<sup>2</sup>Phosphorus dissolved in Chloroform.

# Preparations for External Use.

To this class belong Ointments, Cerates, Suppositories, Plasters and Papers. The Vehicle, sometimes incorrectly called the "base," of the three first mentioned consists of fatty substances; of Plasters either Lead Plaster, resins, oleoresins, or mixtures of these.

The preparations for external medication are classified according to their *fusibility*, or melting points, because their therapeutic uses as well as their pharmaceutical forms are through this quality respectively determined.

*Ointments* fuse at the body temperature and therefore produce an emollient effect, or induce the *absorption* of the medicinal substance by the system.

*Crates* have a higher fusing point, due to Wax they contain; the medicinal agent is not so readily absorbed and they are therefore used to produce *local* effects.

*Suppositories* have the same fusibility as cerates and may be said to be cerates intended for application to the *orifices* of the body.

*Plasters* have a still higher fusibility; they do not melt but become *adhesive*, i.e. by the body temperature and are intended to produce *local* effect and afford *mechanical support* to the parts affected.

The *fusibility* is likewise governed by the respective Vehicles employed.

## OINTMENTS—UNGUENTA.

Ointments are mixtures of a fatty vehicle with which medicinal agents are incorporated, readily fusing at the body temperature  $35^{\circ}$  to  $40^{\circ}\text{C}$ . ( $95^{\circ}$  to  $104^{\circ}\text{F}$ ).

The *vehicles* used are: Benzoated Lard, Ointment (simple), Lard and Wax or Spermaceti in different proportions, Lard Oil, Olive Oil and Suet. Petrolatum and Wool-Fat are employed in unofficial ointments.

The medicinal ingredients must be minutely distributed through the vehicle in order that the ointment may not prove irritating and that the greatest possible surface be presented to the epidermis with a view to quick and uniform absorption. For this reason the highest quality of an ointment (next to its proper melting point) is *smoothness*. In the preparation of ointments care must therefore be taken that the method employed be such as to yield *smooth* products.

The melting point is governed by the fusibility of the vehicle used, which is either officially directed, as in official preparations, or in extemporaneous preparations prescribed by the physician.

The 23 official Ointments are prepared: (1) by mechanical admixture, (2) by fusion, or (3) by chemical reaction.

(1) Mixing the medicinal substances with the fatty body in a mortar, or on a slab, is the process usually employed for solid substances, especially when insoluble in the fat. Powdered Drugs, Acids, Alkaloids, Extracts and Salts (not attended by chemical union) are examples adapted to this process.

The following points must be observed:

The *solid* must be in a very fine powder; a small portion of the fat must first be intimately mixed with the powder and the remainder of the vehicle then thoroughly incorporated until a perfectly homogeneous mixture is obtained.

*Extracts*, especially when hard, are softened by the addition of a small quantity of Water or Alcohol, according to the solvent used in their extraction; then mixed with a small portion of the fat, and finally incorporate with the whole quantity.

*Acids*, such as Boric, Carbolic, Gallic, Tannic, etc., are readily incorporated; a more intimate mixture, however, is obtained when the fat is fused previous to admixture with the drug, but the product then requires to be stirred diligently until cold.

In the preparation of ointments of heavy, dry powders, it is difficult to prevent the agglomeration of the insoluble substance. The method usually followed is to triturate the powder into a cream with a small quantity of Olive Oil, then add the vehicle; glycerin should not be used for this purpose since it is incompatible with fats. The best method is to triturate the powder with the previously melted fat, added in small quantities at a time, in a warm mortar, and straining the liquid mixture through a warmed, coarse sieve, or coarse cloth. This process is especially to be commended in preparing Ointment of Zinc Oxide.

Official ointments prepared by simple admixture are the following:

	<i>Parts of Drug in 100.</i>	<i>Vehicle.</i>
<b>UNGENTUM—</b>		
Acidi Carbolici.....	5	ointment
Acidi Tannici .....	20	benz.lard
Belladonnae (dil alcohol 5) .....	10	"
Chrysarobini (chrysophanic acid) .....	5	"
Gallæ .....	20	"
Hydrargyri (blue ointment).....	mercury 50	
	mercury oleate 2, suet 23, lard	25
Hydrargyri Ammoniati.....	10	benz.lard
Hydrargyri Oxidi Flavi.....	10	ointment
Hydrargyri Oxidi Rubri (castor oil 5).....	10	"
Iodi (potass. iod. 1, water 2 parts) .....	4	benz.lard
Iodoformi.....	10	"

**UNGUENTUM—**

	<i>Parts of Drug in 100.</i>	<i>Vehicle.</i>
Plumbi Carbonatis .....	10	benz.lard
Plumbi Iodidi .....	10	"
Potassii Iodidi (sod. hyposulph. 1, water 10).....	12	"
Stramonii ext., (dil. alc. 5).....	10	"
Sulphuris (washed) .....	30	"
Veratrinae (olive oil 6).....	4	"
Zinci oxidii.....	20	"

(2) Substances readily fusible should be *melted*, when prepared in the form of ointments, so that they may be more intimately mixed.

The substance having the highest melting point, i. e., wax or plaster, is first melted; the fat is then added; when complete liquefaction is effected, the mixture is strained and then stirred until cold.

The following are official:

UNGUENTUM (Simple).....	lard 80, yellow wax 20
Aquaæ Rosæ.....	spermaceti 12.5, white wax 12
(Cold Cream).....	expressed oil of almond 60 then incorporate, borax 0.5, rose water 19
Diachylon (Hebra's) .....	lead plaster 50 oil lavender 1, olive oil 49
Picis Liquidæ .....	yellow wax 12.5, lard 37.5, tar 50

(3) By *chemical reaction*, whereby the character of the medicinal substance, and also that of the vehicle, is changed.

The only ointment of this class official is that of mercuric nitrate, in which the mercury is acted upon by nitric acid, forming mercuric nitrate and the lard is oxidized by another portion of the acid, forming a new compound termed *claidin*.

	<i>Parts in 100.</i>
Unguentum Hydrargyri Nitratis. . . mercury 7, dissolve in nitric acid 10.5	
incorporate with lard oil 76, previously treated with nitric acid 7.	
At a temperature 100°C and allowed to cool 40°C, avoiding contact with iron.	

The Oleates, closely related therapeutically to the ointments, have already been considered.

### CERATES—CERATA.

Cerates are mixtures of fats similar to the ointments, but of firmer consistency, because they contain Wax or Resin, having a higher melting point than lard, in greater proportion than do ointments. In the preparation of cerates the same rules are to be observed as noted under ointments.

The six official cerates are divided into two classes:

(1) Prepared by fusion or simple admixture:

		<i>in 100.</i>
CERATUM (Simple) .....	lard 70, white wax	30
Camphoræ.....	lard 60, white wax	30
	camphor liniment	10
Cetacei.....	white wax 35, spermaceti	10
	olive oil	55
Plumbi Subacetatis.....	solution lead subacetate	20
(Goulard's cerate)	camphor cerate	80
Resinæ.....	yellow wax 15, lard 50, resin	35
(Basilicon)        in cold weather	" 12, " 53, "	35
(2) By maceration, digestion and evaporation:		
Ceratum Cantharidis .....	oil turpentine 15, cantharides	32
(Blistering cerate) mix and macerate for 48 hours, then add to lard		22
	yellow wax, resin, each	18
	previously fused, and evaporate to 100	

The maceration in Turpentine Oil and subsequent digestion renders the vesicating principle of the Cantharides soluble and the preparation hence more active.

### SUPPOSITORIES—SUPPOSITORIA.

Suppositories may be defined as variously shaped masses of medicated fat, possessing a consistence insuring their quick fusion when introduced in the orifices of the body.

The U. S. Ph. gives a General Formula for preparing suppositories; only one Suppository is official and this is not made from Cacao Butter.

The U. S. Ph. defines Suppositories as to their *weights* and *shapes*, corresponding to their several uses, i. e., for introduction in the respective orifices of the body:

*Rectal*, cone-shaped, should weigh 1 Gm.

*Urethral*, pencil-shaped, should weigh 1 Gm.

*Vaginal*, globular, should weigh about 3 Gm.

The vehicle is Cacao Butter (*oleum theobromatis*), which possesses the property of melting at the temperature of the human body 35° C. (95°F.), and yet remaining firm at ordinary temperatures. An addition of 10 per cent of spermaceti has been recommended to raise the melting point and thus give more stability to suppositories during the heated seasons of the year.

The *method* of preparing suppositories are quite numerous: any process may be employed by which the product is obtained uniform in size and shape and with the medicinal ingredients thoroughly incorporated. Moulds are usually employed, the medicinal ingredients, if solid, are first reduced to powder in a mortar, and mixed with a small quantity of the grated Fat; the remainder of the Fat previously melted and cooled to 35° C. is then gradually incorporated with this mixture, thoroughly mixed, and if possible, without further heating, poured in the moulds, previously chilled.

Another process consists in rolling the mass on a slab, cutting it as in making pills, and forming the cones with the fingers. By cold compression in a screw-press "machine," suppositories may be formed from the prepared mass.

*Suppositoria Glycerini*—Made by reaction of Sodium Carbonate 0.3, in Glycerin 6 Gm., with Stearic Acid 0.5 and heating until a solution of sodium stearate or soap is formed, which is poured into a mould. Upon cooling, the mixture gelatinizes and the suppository is wrapped in tin foil.

*Uses*.—Upon introduction in the rectum the mass melts and the Glycerin, acting dissolving upon the faeces, produces evacuation.

### PLASTERS—EMPLASTRA.

Plasters are mixtures of various fatty or resinous solids of such high melting point as to be friable when cold, but rendered adhesive by the warmth of the body.

The vehicles of plasters are: Lead plaster; Resinous substances, made adhesive by admixture with the medicinal ingredients, and simple plasters, such as Isinglass.

The making of Plasters does not differ materially from the process employed for ointments and cerates, since they are all prepared by melting the various substances, and incorporating the medicinal substances last. Care must be taken, however, that the heat be not continued too long, lest the product be impaired.

The spreading of plasters, though usually done on a large scale, may be easily effected by the pharmacist with the use of a plaster iron.

The thirteen official plasters may be divided into:

(1) Lead Plasters, (2) Pitch and Gum Resin Plasters and (3) Isinglass Plaster.

(1) The most important plasters are made from Lead Plaster, or lead plaster mixed with resin, the official Resin Plaster.

*in 100.*

EMPLASTRUM PLUMBI . . . . .	olive oil 60, lead oxide 32 (Diachylon)	mix and add to water 10
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Boil the mixture until the reaction has ceased and the plaster is of the right consistence, when cooled in water, replacing water lost by evaporation from time to time.

The reaction has been explained under the Oils.

Emplastrum Resinæ . . . . .	yellow wax 6, resin 14 (Adhesive)	lead plaster 80
" Saponis . . . . .	lead plaster 90, soap 10	
from these the following are prepared:		
Emplastrum Arnicæ . . . . .	resin plaster 67, extract arnica root 33	
Belladonnæ . . . . .	ext. belladonna leaves 20 resin plaster, soap plaster, each 40	
Capsici . . . . .	resin plaster, oleoresin capsicum q. s.	
Hydrargyri . . . . .	lead plaster 70, mercury oleate 1.2, mercury 30	

containing lead plaster and pitch:

Emp. Ferri.....	olive oil 5, ferric hydrate	9
(Strengthening)	Burgundy pitch 14, lead plaster	72
Opii.....	Burgundy pitch 18, lead plaster 76, ext. opium	6
Picis Cantharidatum .....	Burgundy pitch 92, cerate cantharides	8
(Warming).		

(2) Pitch and Gum Resin Plasters:

EMPLASTRUM:

Ammoniaci cum Hydrargyro.....	oleate mercury 0.8, mercury	18
	ammoniac 72, dil acetic acid, lead plaster, to	100
Picis Burgundicæ.....	olive oil 5, yellow wax	15
	Burgundy pitch, to	100

(3) Isinglass Plaster:

Emplastrum Ichthyocollæ, Court Plaster.

A solution of 10 Gm. Isinglass is dissolved in hot Water 120 Gm.; one half of the solution is spread upon Silk (taffeta) in successive layers and when dry the other half of the solution is spread on in a similar manner, after first having been mixed with Alcohol 40 Gm., Glycerin 1 Gm. The taffeta is then coated on the reversed side with Tincture of Benzoin.

PAPERS—CHARTÆ.

There are two Papers official. One is made by saturating strips of white, unsized Paper in a 20 per cent solution of Potassium Nitrate and drying; the other is Paper coated with Mustard used similarly to the Plasters:

Charta Potassii Nitratis ..... potass. nitrate 20, water 80  
Vapors from inceration as inhalant.

Sinapis..... oil-free black mustard, 60 sq. cm. 4 Gm.  
The Mustard is freed from the fixed oil by extraction with Beuzin and mixed with a solution of India-Rubber in equal volumes of Beuzin and Carbon Disulphide and spreading upon Paper.

## Dispensing.

With the subject of dispensing is intimately connected that of the organization of a pharmacy, the utensils, shelf-bottles, fixtures and its arrangement generally. An adequate description of these can not be given here, and the student is referred to the various works on pharmacy.

Apparatus, involving a knowledge of the principles governing their construction and employment in pharmaceutical processes, such as drug-mills, funnels, stills, condensers, etc., have already been described in connection with the respective operations.

A pharmacy should be organized from a dispensing standpoint, so as to combine in order of their importance:

(1) Identity and convenience. (2) Preservation and cleanliness.

The term *identity* is here applied more especially to the arrangement of containers, with a view to prevent mistaking one substance for another; the dispensing of poison naturally comes under this division. The Nomenclature of the labels governs this to a great extent, and if it be perfect and all containers arranged in *alphabetic* order, the safest plan of preventing mistakes is secured to competent dispensers, while to those less advanced it is the only true or scientific method.

Many objections have been urged against this system, the most pertinent being that the alphabetic arrangement sometimes brings a powerful remedy (*heroicum*) next to one possessing very mild properties, as, for example, *Tinctura Opii* and *Tinctura Opii Camphorata*, etc. This objection, however, can not be sustained, because all poisons and remedies possessing great activity, though not always classed as poisonous (termed *heroica* in the Continental Pharmacopœias) should be kept in containers of a capacity adapted to the comparatively smaller quantity required for dispensing purposes.

To illustrate: *Tinctura Opii*, if included in the general arrangement at all, should be kept in a bottle not exceeding one pint capacity, while the container for *Tinctura Opii Camphorata* should hold at least two pints.

It has also been proposed that the old Latin names in some cases be substituted for the Pharmacopœial titles, as, for example, *Sal Rochelle* and *Tartarus Emeticus*, for their respective official chemical names. There are some good reasons for this, in that the official names of these two compounds, on contain-

ers of nearly the same size, especially if the names be incorrectly abbreviated, may easily be mistaken for each other, viz.: Sod. Pot. Tart. and Ant. Pot. Tart. But the great difference in the respective *quantities* kept on hand for dispensing purposes of these and other similarly related substances may be trusted to guard against confusion. The plan is, moreover, without justification, for the reason that it would perpetuate arbitrary synonyms without scientific warrant.

A strict adherence to the Pharmacopœial nomenclature, with a *faultless abbreviation* on all containers, will not only tend to guard against errors in dispensing, but is also desirable because of its great *convenience*. It enables those familiar with Pharmacopœial nomenclature to find at least official substances with ease in any pharmacy, and, while a correct system affords the beginner much instruction and information, a confused or inaccurate one will prove exceedingly inconvenient, annoying, and be frequently fraught with serious consequences. But, in order that fatal mistakes may be as far as possible prevented, all substances known as *poisonous* should be kept in separate compartments, preferably under lock and key.

The *isolation* of poisons seems to be the most practicable, as it is the safest method of all the plans proposed, for preventing mistakes of a fatal character in dispensing. As an additional precaution the substances should be left in the original containers, as these usually are each characteristic as to size and proportions. Of the various devices designed for this purpose, there are containers of colored glass, painted black, covered with sand paper, or provided with odd stoppers with jagged edges to rouse the attention of the dispenser; none of these, it is believed, can be relied upon unless the poisons are also kept in a separate place.

A case especially arranged for poisons such as that designed by Mr. H. Biroth (See Proc. Am. Pharm. Assoc., 1884) combines the advantages of compactness and convenience and is well adapted for this purpose.

Upon the theory that mistakes frequently occur because of absent-mindedness on the part of the dispenser, it has been proposed that all poisons be kept in a drawer, in which the containers are promiscuously thrown, thus compelling the dispenser carefully to examine the label for such as may be wanted for use.

#### PRESERVATION.

The preservation of medicinal agents is a very important part of the pharmacist's duties. Many of them, while originally of good quality, under certain conditions, such as exposure to light, changes in temperature, etc., deteriorate and not infrequently spoil.

The attention to be observed in the preservation of crude drugs of vegetable origin has already been pointed out, and the requirements

in this respect for chemical compounds are indicated in the previous lectures.

But a still more important, if not larger, class of substances are left for consideration, namely, the so-called Galenic preparations, and especially those of a liquid character. Among these, the weaker preparations (that is, solutions not saturated, such as tinctures, spirits, medicated waters, solutions, etc.), are, as a rule, preserved without much difficulty, although undue exposure should as far as possible be avoided. Essential and Fixed Oils and preparations of the latter, such as Ointments and Cerates and Plasters, should be kept in a cool and dark place, and be well protected from the atmosphere, in tightly stoppered containers.

In *saturated* solutions preservation is more difficult, especially with compound preparations containing various ingredients, as, for example, Elixirs and Fluid Extracts. In many of these, upon exposure to the slightest change in temperature, some constituent is thrown out of solution, giving to the preparation a cloudy appearance or precipitate, either of which is very undesirable. Such preparations should be kept at a temperature as near as possible to that at which they were prepared.

Syrups and Emulsions, owing to their consistence, rarely precipitate, but, since they do not contain any alcohol, they are liable to ferment or otherwise spoil, when exposed to warmth, and they should therefore be stored in a cool place.

The ordinary glass-stoppered bottles are not adapted to syrups, because the caking of the syrup in the neck of the bottle will make the withdrawal of the stopper exceedingly difficult and sometimes at the danger of fracturing the container. To avoid this difficulty, so-called "syrup bottles" are sometimes used in which the stoppers rest loosely upon the enlarged neck of the bottle, inside of which the stopper proper is suspended without coming in contact with the sides. The objection to this form of container is, that the air is not excluded, and the syrup is therefore liable to spoil. The best kind of containers for syrups and all saccharine liquids are ordinary bottles with corks and written labels; these are more convenient, are easily cleaned, and, in case of breakage, are comparatively inexpensive; besides, the syrup may be poured into them whilst hot, without injuring the label.

The *preservation* of Fluid Extracts presents probably more difficulties than any other single class of preparations, for the reason that they are usually saturated solutions of organic substances or principles, which, upon the slightest exposure, and frequently without exposure, become insoluble, and are thrown out of solution until heavy precipitates are formed. This precipitation often continues until a very

large proportion of the extracted matter, which often represents the most valuable principles of the drug, is precipitated, and the preparation becomes more or less inert.

This precipitation is sometimes due to exposure to changes in temperature, but most frequently to the employment of menstrua not capable of holding the extracted matter in solution. Other causes, however, at present not fully known, also operate to induce this change, which is singular in that when it has commenced it continues to develop, and the precipitate can not be redissolved without largely increasing the quantity of liquid. To prevent precipitation these preparations should be kept at even temperature, preferably about 15°C., and care should be taken that the proper menstrua be employed in their manufacture. The containers should be ordinary bottles, preferably of amber glass, so as to exclude the actinic rays of sunlight, which appear to have a decomposing action upon preparations containing a large proportion of chlorophyll; they should also be provided with tight-fitting corks, so as to prevent evaporation of the alcohol. Different lots of fluid extracts of the same drugs should never be mixed, as the slightest change in the alcoholic strength of the menstrua in different specimens will induce precipitation.

The *preservation* of Solids, embracing also mixtures of solid substances in various forms, such as Cerates and Ointments, while not as difficult as with preparations in the liquid form, deserves considerable attention, because their preservation involves also, to a great extent, a feature very essential in the practice of pharmacy, namely, *cleanliness*.

With Extracts (solid) it is especially to be observed that they should be kept in a cool and dry place. Those made with aqueous menstrua, such as extract of Taraxacum, are liable to ferment, when they swell and exude around the cover of the jar, defacing the label and the furniture. Extracts made with alcoholic menstrua, such as Aconite, Nux Vomica, etc., by exposure to a warm temperature, become dry and hard, rendering their dispensing difficult. Both of these undesirable tendencies of the extracts may, to some extent, be counteracted by the incorporation of five per cent of glycerin in many of them when prepared, but glycerin readily absorbs moisture, and its presence in extracts, which are also naturally hygroscopic, increases this quality, hence the necessity of storing extracts in a dry place.

These observations apply also to Abstracts or Powdered Extracts, Masses, Confections, Pills, and all the various classes of preparations of mixtures of solids.

With preparations of an *oleaginous* character the same general rule is applicable as to high temperature and moisture. Many Cerates and Ointments, however, are prone to become rancid with the best of precautions, and they should be prepared either in very small quantities only, or as in the case of Cerate of Lead Subacetate, be prepared *extemporaneously*.

## GENERAL DISPENSING.

The dispensing of liquids is done by measure—except with a few substances, such as acids, glycerin, ether, etc., when sold in considerable quantities or used for a specific purpose.

The measures in use are chiefly of glass, graduated either according to the U. S. fluid measure, the Metric system in cubic centimeters, or according to both upon opposite sides.

In dispensing a mixture of any character, the dispenser should ascertain, first of all, that every article required for its completion is on hand.

The practice, however, of taking down all containers at one time, which is sometimes done with this object in view, so as to place them within easy reach, is not to be recommended, for reasons explained under the dispensing of prescriptions.

The next step is to provide the bottle or container with a good cork, which should fit accurately; the very best quality of corks will be found the cheapest in the end; nothing is so apt to displease a patron as to find a poor, worm-eaten or short-cut cork in a bottle.

In measuring a liquid into a "graduate" from a shelf-bottle, care should be observed that:

(1) The measure be held by grasping the base of the vessel firmly between the thumb and the index finger of the left hand, bringing it up so as to be on a level with the eye.

(2) The container is taken down from the shelf, after the label has first been carefully read, with the right hand placed near the bottom.

(3) The stopper is then clasped between the free little finger of the left hand, extracted, and the contents poured into the measure with great exactness.

(4) The remaining drop upon the lip of the bottle is then, by a dexterous movement, wiped off on the stopper, the latter inserted, and the container placed back on the shelf, after again carefully reading the label.

(5) The liquid having been poured in, the bottle is carefully stoppered with a cork, the top extending so that it may be easily extracted with the fingers, but yet so secure that any jolting the package may receive will not be sufficient to dislodge it.

The labeling is also an important part of dispensing. The label should be plain and printed in black ink, except with those of poisons, which may be in *red* ink. When blank labels are used, the name should be written in a bold and legible handwriting, without flourish.

*Labels* should, as far as practicable, contain such information as may be essential to an intelligent use of the article; for example, with glycerin, "that it be diluted with a little water before applying it to raw surfaces," or with castor oil how the taste may be best masked, etc. With all powerful remedies the labels should bear the doses, with some injunction that care be observed in its employment, at least when for internal use.

The *paste* should combine adhesiveness, cleanliness and cheapness; Dextrin mucilage possesses these qualities better than any made from acacia, tragacanth or flour. It is prepared by heating four ounces of dextrin in eight ounces of water and one ounce of acetic acid until it is dissolved; then add one ounce of alcohol to preserve it. This mucilage is used for gumming postage stamps.

In *labeling* a bottle, the label should be affixed, if the proportions admit, so that the center of the label will be about three-fifths the distance from the bottom of the bottle. It must never be placed across the seam on round vials, but exactly between the two seams, and should always be perfectly horizontal.

### DISPENSING OF SOLIDS.

The dispensing of solids, to be treated in this connection from a purely mechanical standpoint, requires no special observation, as it involves merely weighing and making packages.

"Wrapping packages," as it is called, though apparently a trivial performance, is one to which considerable importance is attached by expert pharmacists, and when carried to perfection becomes an art which even the public does not fail to appreciate. The exterior of packages, no less than of the dispenser himself, tends to influence a favorable impression of the skill of the pharmacist and promote personal confidence and esteem. This to the pharmacist is of incalculable value, and, as the extra outlay is slight, it is well worthy his consideration.

The *art* of wrapping a package artistically may easily be acquired by any one possessing adaptability and patience; but as success depends chiefly upon practice and experience, the subject can not be treated here, except in calling attention to a few general rules to be observed. These are:

(1) Suitable paper.

None with ragged edges should ever be used, except for heavy goods, when old wrapping paper may be employed.

(2) Paper of proper size.

An assortment of different sizes should invariably be kept on hand, in compartments under the counter, convenient to the scales.

(3) Properly folded.

The package to be so made, that the center of the double crease shall be exactly in the center of the package, the ends folded over so as to present a per-

factly square knife-edge, and so far that their ends meet. The package should be plump and nearly square, rather than flat and long. Many articles can not be wrapped so as to conform to these general directions, but with most crude drugs this method gives a package of correct proportions and neat appearance.

(4) Correctly labeled.

It is as necessary that packages of solid substances be labeled, as are bottles containing liquids, although, except in the case of poisons, it is usually neglected. The label should be placed immediately over the center of the double crease, and attached with the smallest quantity of paste, barely sufficient to prevent it from slipping off. This enables the purchaser to easily remove it and attach it to a container.

(5) Securely tied.

When the package is made, and while it is lying upon the counter right side up, the twine is laid over it along the double crease and then turned over with both hands, the twine being held in position during this operation. After the twine has been crossed in the center this operation is repeated transversely, and the twine then tied in a *bow* knot at the side. This operation can be performed very quickly, and at no time is it necessary to lift the package more than a few inches from the counter, while the exceedingly awkward habit of placing the twine between the teeth is avoided.

The following mixtures of Solids are unofficial:

*Cataplasma*.—Poultices Ground substances such as Bran, Oatmeal, Flax-seed or Ulmus mixed with boiling hot water to make a pasty mass to be spread on cloth and applied hot. Mustard Poultice is made of ground Black Mustard or, if a milder effect is required, equal parts of Black and White Mustard mixed with tepid water.

*Cigarettes*.—Mixtures of drugs in coarse powder, such as Eucalyptus, Eriodictyon with clover blossom, etc., adapted to smoking for the relief of Catarrh, etc.

*Spirits*.—Teas—Mixtures of various drugs contused or coarsely comminuted for decoctions or infusions.

#### SOLUTIONS AND MIXTURES:

*Collyria*.—Eye Washes—Weak aqueous solutions for dropping or instilling in the eye.

*Gargarisma*.—Gargles—Solutions or aqueous mixtures of salts or astringent drugs for gargling.

*Haustus*.—Draught—A term applied to a liquid medicine usually to be swallowed at one "draught."

*Injectiones*.—Injections—Aqueous solutions of about 1 per cent strength for injecting in the urethra or vagina or for introduction under the skin—subcutaneous—with the hypodermic syringe.

*Inhalationes*.—Inhalations—Volatile liquids adapted to inhalation of vapors.

*Lotiones*.—Lotions—Washes, antiseptic, aqueous mixtures containing insoluble substances or solutions of antiseptic agents.

*Nebule*.—Sprays—Solutions sprayed in the body orifices by an atomizer.

*Enemata*.—Enemas or Clysters—Aqueous mixtures for injection in the rectum to evacuate the bowels or to serve as nourishment.

# Prescriptions.

Prescription is literally a written order for something—from *præ*, for, and *scribo*, I write. Its popular use, however, relates to medicines, usually meaning a written order for medicines, though it is frequently employed to designate the remedy or mixture itself. In reading prescriptions the most important considerations are:

- (1) The language and abbreviations.
- (2) The signs and terms.

The language of prescription-writing is primarily Latin, because the pharmacopeial titles are chiefly used in designating remedies. In other features, however, such as directions to be written on the label, Latin is rarely employed in America, and, when used, is usually its own condemnation.

## LATIN IN PHARMACY.

A Nomenclature that can be understood by pharmacists of all civilized nations is as important to the profession of pharmacy as a scientific nomenclature of animals and plants is to the zoologist and botanist.

Because it is a language with which most scholars are familiar and because of its flexibility, Latin has by common consent been adopted in the naming of drugs and pharmaceutical preparations. Besides, it is a common, though by no means a universal, practice, for physicians to write their prescriptions in Latin.

An elementary knowledge of the language is, therefore, of considerable importance to the pharmacist. We can not, of course, undertake here to give the student a course in Latin. Those who have not had the advantage of attending schools where Latin is taught, should become familiar with the rudiments of the language by studying Robinson's Latin Grammar or some similar work especially adapted to pharmaceutical students.

To illustrate the use of Latin in prescription writing, the following example is given:

B.	<i>Acid. Arsenos</i>	gr. 1
	<i>Ferri Pyrophos</i>	3 ss
	<i>Res. Podophyl</i>	gr. v.
M.	<i>S. A. ft. Mas. et div. in pil. xx.</i>	
S.	<i>Una pil. detur bis in die.</i>	

Unabbreviated the same prescription would read as follows:

Recipe: Acidi Arsenosi granum unum, Ferri Pyrophosphatis drachmam semis, et Resinae Podophylli grana quinque. Misce secundem artem, fiat massa, et divide in pilulas viginti.

Signa: Una pilula detur bis in die.

Literally translated it reads as follows: Take thou of Acid Arsenous grain one, of Iron Pyrophosphate, dram a half, and of Resin or Podophyllum grains five. Mix according to art, let be made a mass, and divide into pills twenty.

Write: One pill let be given twice in a day.

Or, putting the translation in the proper English order, the prescription will read:

Take of Arsenous Acid a grain, of Iron Pyrophosphate half a dram, and of Resin of Podophyllum five grains.

Mix according to art, let a mass be made, and divide into twenty pills.

Write: Let one pill be given twice a day.

#### ANALYSIS.

*Recipe* is a verb in the active voice, imperative mode, present tense, second person, and singular number; agreeing with *tu* (thou) understood.

*Acidi* is a neuter noun of the second declension, in the singular number and genitive case.

*Arsenosi* is an adjective agreeing with its noun, *acidi*, in gender and number and case.

*Granum* is a noun of the second declension, neuter gender, singular number and accusative case, the direct object of the word *Recipe*.

*Unum* is a numeral adjective agreeing with its noun *granum* in gender and number and case.

*Ferri* is a neuter noun of the second declension, in the singular number and genitive case.

*Pyrophosphatis* is a masculine noun of the third declension in the singular number and genitive case.

*Drachmam* is a feminine noun of the first declension in the singular number and accusative case, and governed like *granum*.

*Semis* is a numeral adjective agreeing with its noun *drachmam* in gender, number and case.

*Et* is the conjunction *and*, connecting the preceding two clauses to the one following.

*Resinae* is a feminine noun of the first declension, in the singular number and genitive case.

*Podophylli* is a neuter noun of the second declension in the singular number and genitive case.

*Grana* is a neuter noun of the second declension found in the plural number and accusative case.

*Quinque* is a numeral adjective qualifying *grana*.

*Misce* is a verb (from *misceo*) in the active voice, imperative mode, present tense, second person, singular number, agreeing with *tu* (thou) understood.

*Secundem* is a preposition governing

*Artem*, which is a noun of the third declension, singular number, feminine gender and accusative case.

*Fiat* is a verb (from *fio*) in the active voice (in form though not in meaning), subjunctive mode, present tense, third person, singular number, agreeing with its subject, *massa*.

*Massa* is a feminine noun of the first declension, singular number and nominative case, the subject of *fiat*.

*Et* is a conjunction connecting *misce* and *divide*.

*Divide* is a verb (from *divideo*) in the active voice, imperative mode, present tense, second person, singular number, agreeing with *tu* understood.

*In* is a preposition governing *pilulas*.

*Pilulas* is a feminine noun of the first declension in the plural number, accusative case and governed by *in*.

*Viginti* is a numeral adjective qualifying *pilulas*.

*Signa* is a verb (from *signo*) in the active voice, imperative mode, present tense, second person, singular number, and agrees with its subject *tu* understood.

*Una* is a numeral adjective, feminine gender, singular number, and nominative case, qualifying *pilula*.

*Pilula* is a feminine noun of the first declension in the singular number and nominative case, the subject of the verb *detur*.

*Detur* is a verb (from *do*) passive voice, subjective mode, present tense, third person, singular number, and agrees with its subject, *pilula*.

*Bis* is an adverb modifying *detur*.

*In* is a preposition governing *die*.

*Die* is a noun of the fifth declension, masculine (or feminine) gender, third person, singular number and ablative case, governed by the preposition *in*.

A prescription may be divided into five parts, as follows:

- (1) The superscription—**B.** For . . . . .
- (2) The inscription, i. e.: 

Tincturæ Opii . . . . .	ʒ	i
Syrupi . . . . .	ʒ	i
Aque Cinnamomi . . . . .	ʒ	i
- (3) The subscription, i. e.: Misce.
- (4) The signa, i. e.: Sig. One teaspoonful every hour.
- (5) The name of the prescriber and the date.

The *superscription* consists of the mark **B** (an abbreviation of the imperative of the verb recipio—*recipe*, which means “take thou,”) and the Name of the patient. The latter is too frequently omitted. A perfect prescription should always bear the name of the person whom the medicine is intended for, and if for a child it should be so designated.

The *inscription* is the most important part of the prescription, because it embraces the names of the different ingredients and their quantities, which are written in the genitive:

**B Quininæ sulphatis**—Take of quinine sulphate.

The rule is, therefore, that every word in the inscription must terminate in the *genitive*.

They are rarely written out in full, however, but are nearly always abbreviated. In the case of words having the first, or the first and second, syllables the same, as, for example, Hydrargyrum and Hydrastis, the abbreviation must not be carried so far as to involve doubt as to what substance is really wanted. To illustrate, the drugs just named are often abbreviated Hydr., which may mean either of them, or, when followed with chlor., would mean Chloral Hydrate (chloral), but might also be mistaken for Hydrargyrum Chloridum; both Calomel and Mercuric Chloride (corrosive sublimate) being sometimes very improperly, though not infrequently, so written. In such cases the dispenser must carefully judge what article is intended by computing the dose and from a consideration of the other ingredients.

In compounds or mixtures the ingredients may be classified from the standpoint of prescribing into: (1) The base or active constituents, the *basis*. This term is frequently but incorrectly applied to the substances employed to give form to the medicinal agents. The basis of the prescription must be the active constituent, both pharmaceutically and therapeutically considered.

(2) The forming substance. This is variously termed according to the form or consistence of the mixture: For liquids and ointments—*vehicle*, i. e., syrup and petrolatum respectively; in the form of powder—*diluent*, i. e., milk sugar, and when in a mass, as in the form of pills or troches—*excipient*.

(3) The *corrective* is the addition of any agent which modifies the action of the active ingredient, as, for example, syrup of ginger in some mixtures, or capsicum in purgative pills.

(4) *Adjuvant* is a term given to such ingredients as may be added to increase the action of the base, but since these frequently are quite as potent as the principal remedy, the distinction is rarely made, and not here considered. These divisions are illustrated as follows:

Form.	Base.	Vehicle.	Diluent.	Excipient.	Corrective.
Liquid.....	Potassii iodidi...	Aquæ. Syrupi...	.	.	Tinct. Zingiber.
Powder.....	Hydrargyri chloridi mite.....	.	Sacchari lactis....	.	.
Pill.....	Hydrargyri chloridi corrosivi.....	.	Pulvis	Glycerit.	.
Ointment.....	Zinci oxidii.....	Unguenti benzoini.	althææ...	amylí...	.

The *subscription* consists of signs or terms conveying directions as to the compounding and dispensing. When only one substance is prescribed, it is usually omitted; in the case of mixtures of liquids or solutions, the mark M., or *misce* (mix), is generally affixed.

The most common terms employed are, abbreviated :

M. ft. sol.	mix and make a solution.
M. ft. colat.	mix and strain the liquid.
M. ft. pulv.	mix and make a powder.
in Chart. divide	divide in papers (No.—)
M. ft. mass. pil. div.	make a mass, divide in pills.
M. ft. ung.	mix and make an ointment.

In case no especial directions are given, the pharmacist must employ his skill in compounding the mixture, that not only will the full medicinal effects be derived, but when possible also, that it be presented in the most agreeable and palatable form, expressed in the term *secundum artem*.

The *signa* or the directions to be written on the label and affixed to the package or container. These are usually written in English, though sometimes, especially by European physicians, in Latin. There is no good reason for writing the directions other than in English, and in a plain, bold hand-writing. No secrecy is here necessary, as is sometimes desirable in the inscription. On the other hand, it may serve as a check on any errors in the label incident to dispensing. Abbreviated terms should be carefully scrutinized when employed, before writing the label, and the stereotyped expression, "Use as directed," should as far as possible be avoided. Many serious consequences might have been averted if concise directions were given.

The following Latin terms, more or less abbreviated, are used in the directions:

Bis in die.	Bis in d.	Twice a day.
Capiat.	Cap.	Let him (or her) take.
Cochleare.	Coch., Coch.	A spoonful.
Cochleare magnum.	Coch. mag.	Tablespoonful.
Cochleare medium.	Coch. med.	Dessertspoonful.
Cochleare parvum.	Coch. parv.	Teaspoonful.
Da, detur.	D., det.	Give, let be given.
Dentur tales doses.	Dent. tal. dos.	Give of such doses.
Diebus alternis.	Dieb. alt.	Every other day.
Diebus tertiis.	Dieb. tert.	Every third day.
Dinnidius.	Dim.	One-half.
Donec.		Until.
Durante dolore.		While the pain lasts.
Harum pilularum sumantur tres	Har. pil. sum. iii.	Let three of these pills be taken.
Hora.	H.	An hour.
Hora somni.	H. S., Hor. Som.	Before retiring.
In dies.	In d.	From day to day.
Inter.	Int.	Between.
Magnus.	Mag.	Large.
Mane, mane primo.		In the morning.
Modo præscripto.	Mod. præscript.	In the manner prescribed.
More dictu.	More dict.	In the manner directed.
Ne tradas sine nummo.	Ne. tr. S. num.	Do not deliver unless paid.
Nox, noctis.		Night.
Numerus.	No.	Number.
Omni hora.	Omn. hor.	Every hour.
Omni bihorio.	Omn. bihor.	Every two hours.
Omni quadrantehoræ.	Omn. quadr. hor.	Every quarter of an hour.
Omni mane.		Every morning.
Omni nocte.		Every night.
Primus.		The first.
Pro re nata.	P. r. n.	Occasionally.
Quantum libet placet, vis., volueris.	Q. l., Q. p., Q. v.	As much as you please.
Quaque, quaque.		Each or every.
Semis.	Ss.	A half.
Septimana.		A week.
Sesquihora.		An hour and a half.
Statim.	Stat.	Immediately.
Ter.		Three times
Ter in die, ter die.	T. i. d., t. d.	Three times a day.
Ut dictum.	Ut dict.	As directed.
Utendum.	Utend.	To be used.

The *name of the prescriber* and the *date* are frequently omitted, or at best, the former is given in initials only.

Since pharmacists are usually enabled to identify the prescriber by the hand writing, the initials often suffice, especially since blanks with printed name, address and office hours are to a great extent employed. A much safer plan, however, is to write the name in full, so that errors may be avoided in writing the label.

The *date* should be affixed at the time of dispensing by the pharmacist, so that its omission is of little importance.

*Signs or symbols* are used to designate quantities, and therefore belong to the inscription, but are more conveniently treated separately.

Of those used for designating Apothecaries' weights, the "scruple" and "pound" are going rapidly out of use. For liquids the signs represent only U. S. fluid measures, excepting the "drop," *gutta*, plur. *guttæ*, abbreviated "gtt." which is too indefinite to warrant employment, and should be discarded in favor of the *minim*. These have already been fully described.

The *quantities*, except metric, are always expressed in the Roman numerals.

The numerals i—one; v—five; x—ten; l—fifty; C—one hundred; D—five hundred and M—one thousand. are the basis upon which this system is constructed. It has a symbol for each decimal unit; also one for its first aliquot division, or five times the lowest preceding one as shown above. From these the intervening numbers are constructed by placing the different numerals side by side: i=1; v=5; x=10; vi=6; xv=15; xvi=16; xx=20; xxvi=26.

No numeral is used in sequence, however, more than three times, below one hundred; a higher number is constructed by placing the next lowest units after the lower one, for example: iv=4; ix=9; xl=40; XC=90. Very cautious prescribers, it may be added, frequently use the full word in preference to any abbreviation.

The terms and abbreviations in *metric* prescription writing were treated under the Metric Weights and Measures in Lecture I.

*Signs* for designating the measure or weight of the mixture are sometimes affixed to the last ingredient; of these the most important are:

*Ad*, the preposition "to"; *ad ȝ* vi=to (measure) four fluid ounces. *Quantum sufficiat*, or quantum satis, usually abbreviated Q. S. or q. s.—as much as is sufficient. Of these q. s. should always be preferred since *ad* is susceptible of confusion with the abbreviation of the verb *adde*, to add.

*Ana*, abbreviated *aa*, of each, is appended when the same quantities are required of two or more ingredients; it follows the last of these, preceding the quantity.

*Dentur tales Doses no.*—Let there be given of such doses number—, is a phrase used, especially by foreign physicians, to designate the

number of powders to be dispensed, *each* containing the quantities directed in the inscription.

*Sic, Statim* or the exclamation sign (!) after the quantity, indicates that the dose is exceptionally large, but that the prescriber is aware of this fact and directs the stated quantity for special reasons.

The more general adoption of signs like these would be very desirable, as their presence is exceedingly reassuring to the dispenser, when powerful remedies are prescribed; the first mentioned, *sic*, should be given the preference, as it is less liable to be confounded for a numeral, than the exclamation point (!).

#### THE COMPOUNDING OF PRESCRIPTIONS.

The compounding of prescriptions is the most responsible duty of the pharmacist. It is also the most difficult to fulfil properly, because it involves not only professional skill, but also mature judgment, a cool head and a collected mind.

Probably no other division of human labor makes demands simultaneously upon the exercise of so many faculties as are required of the pharmacist in the compounding of prescriptions. The greatest care, accuracy and skill may be displayed in compounding a mixture, when, in a moment of absent-mindedness, an error may be committed in writing the directions on the label, or placing the wrong label on the package, or, what is worse still, by delivering medicine intended for an adult in place of that for an infant.

All these points must be considered in the dispensing of prescriptions, and they call for constant vigilance on the part of the pharmacist. Upon the receipt of a prescription by him it should be registered as a sacred trust, that the health and perhaps the life of his patron is in his charge, and that this obligation is not discharged until he sees the little package, in which a fond mother's loving hope may be involved, safely in the hands of the proper person. Greater responsibilities may exist in other professions or vocations, involving the care of a greater number of lives and property, as in the operation of means of transportation, but errors or accidents may there usually be avoided by attention to well-known rules, discipline, etc., or dependence chiefly upon mechanical means. In the dispensing of prescriptions, skill, rules and regulations are of little avail unless accompanied with a free mind, a clear head and an acute perception of the apparently most trivial details. In this branch of pharmacy the price of safety is pre-eminently eternal vigilance!

A general plan of procedure in "filling" a prescription will be here outlined in the belief that adherence to it will reduce the chances of error to a minimum, if not entirely exclude them.

## IN RECEIVING THE PRESCRIPTION.

(1) *Note carefully the person who brings it, while he is politely requested to be seated.*

(2) *Glance over the prescription, or all of them if more than one, so as to determine, approximately, the length of time required to complete them.*

(3) *Inquire whether or not he desires to wait, to have it delivered, or to call for it.*

(4) *Make a memorandum accordingly, and in case it is not to be delivered, or called for, note the name and address, unless numbered checks are used.*

To prevent confusion the only safe method in the delivery of prescription medicines is to mark the name of the patient on the prescription. Numbered checks may become lost or exchanged by children when several are waiting. While sometimes the name is not readily learned, still it is the only certain plan by which mistakes in delivery may be entirely prevented.

(5) *Read the prescription closely and deliberately, especially the inscription, making meanwhile a mental inventory to ascertain if the different articles are in stock and in the quantities required. In case of doubt examine the container, but leave it in its place until wanted.*

(6) *Procure the container of proper size and place it upon the prescription as a weight.*

If a bottle, fit it with a long, soft cork, squeezed with a press when necessary until it admits being inserted one-half its length; the other half extending facilitates its extraction with the fingers. The reprehensible practice of chewing the cork should, of course, not be tolerated.

(7) *Procure all the implements necessary for the operation, spatula, mortar, graduate, etc., and place them within convenient reach, having previously made sure that they are clean.*

(8) *Procure the first article desired for incorporation or solution, and weigh or measure it carefully.*

If the inscription is correctly written upon the prescription, the *basis* or active constituents come first, and, if it consists of several, the most active ingredient is first taken, this being, in any event, the rule. The desired quantity having been disposed of, the container is stoppered, the name on the label read deliberately, and then placed upon the desk at one side of the scale; the next article in order of *quantity* or *compatibility* is then procured; the label first being carefully read, the required quantity is obtained, and the container disposed of in the same way as the first and placed by it.

This process is continued until all the articles have been procured and the operation is finished. With very bulky preparations, it is sometimes inconvenient to place the containers on the counter, and this may perhaps be dispensed with.

## WHEN THE COMPOUND IS FINISHED.

(9) *Each ingredient and quantity* should be checked by the dispenser or an assistant on the prescription from the containers left standing upon the counter.

These should then be *immediately* put back in their respective places. This operation may be accelerated by the aid of an assistant. But no move must be made by the dispenser with any other work until the package is labeled, in order that mistakes in labeling may be avoided.

(10) *Any additions and alterations* made in compounding should be explicitly stated upon the prescription, so that in case of renewal, the preparation shall be identical with that originally dispensed.

The *kind* and *quantity* of the various agents employed pharmaceutically such as Excipients for pill-masses, or Emulsifying agents, are not infrequently ignored by the physician, who leaves their selection to the pharmacist. For pharmaceutical reasons it may be necessary to deviate from the formula, in the character or quantity of the Solvent, or to make alterations in the Vehicle, Excipient or Diluent, entailing no objections therapeutically. This must never be attempted, however, except when absolutely necessary, and then, when possible, only with the consent of the prescriber, and *should always be accompanied by the proper memoranda affixed to the prescription.*

(11) *The numbering and dating* of the prescription is next in order. Both should be written in a plain, bold handwriting.

To avoid duplication, or errors in numbering, various devices are employed, the most satisfactory being the "patent dating stamp," to be had with duplicate numbers as high as six figures, at reasonable cost. An inexpensive device may be constructed by writing consecutive numbers upon long strips of paper, one-half inch wide; by pasting these together a thousand or more numbers may be rolled upon a spool in a box, the numbered end extending through a slit in the side. When a prescription is to be numbered, a number is cut off the slip and copied on the prescription, or if gummed it may be attached to it, thus saving writing and insuring consecutive numbers, provided, of course, that the numbers on the slips have been written correctly, and also that this operation is always performed when a prescription is to be numbered.

(12) *Writing the label* should be done, as in all writing pertaining to pharmaceutical work, clearly and distinctly, without flourish or abbreviation.

In writing the directions the *numbers* should always be written, as well as given in numerals; for example:

Two (2) teaspoonfuls every three (3) hours.

This lessens the chance for error by the patient.

The *name* should be appended whenever it can be learned.

The *date* must always be given, as through it a prescription can frequently be found when desired for repetition, when the number in the label has been effaced. In the absence of a generally accepted plan, the number of the month should be given in Roman, the date in Arabic, thus X, 13, 28.

The physician's name should always be written in full.

(13) *Labeling must be done immediately upon the finishing of each mixture or compound, and as soon as the label is written.*

When two or more prescriptions are received for compounding, each mixture should be so completed as to make it impossible to mistake it for another. This can only be done by affixing the label to each, before work is commenced on the next one. In case two liquids are prepared for internal and external use respectively, care must be observed that the labels are not interchanged on the bottles, since mixtures intended for external application usually possess dangerous properties when taken internally.

The following strip labels should always be used when directed upon the prescription; and when therein omitted, though clearly indicated, should be employed with proper discretion:

For External Use. Shake Well Before Using.

The injunction, "for external use," to the public conveys the impression that the mixture must be used only outwardly on the body, and that it does not apply to eye-washes, gargles, injections, etc. While this definition is incorrect, it is best to avoid confusion by the employment upon these of the label, "Not to be taken!"

These strip labels should be attached *above* the label proper, as they are then more conspicuous than when appearing below it. If more than one is used on the same bottle, they may be placed alternately, the most important occupying the most conspicuous position.

(14) *The wrapping of the package* should be neatly done, after which it may be either tied with twine, or, preferably, the ends fastened together with red sealing-wax; black wax should never be used, owing to the superstition of some persons construing its employment as an evil omen.

This is also true in *sealing* the cork tops, which is now chiefly done with the gummed tops in various bright colors. *Capping* the bottle with a piece of glazed paper is an exceedingly attractive manner of finishing the package, and is especially to be commended as it assures the patient that the contents are intact, when procured through the aid of a messenger. This is a feature practiced generally on the Continent, and worthy of adoption here.

(15) *In delivering* the package, care must be observed that no mistake be made in the identity of the medicine or of the purchaser.

In case numbered checks are not used, the name should be ascertained by deliberate questioning. *Verbal instructions* should as far as possible be avoided, as these are liable to cause confusion, reliance being placed upon the instructions upon the label. On the other hand, any inquiries should be met with a clear explanation, that the customer may be perfectly satisfied.

## Extemporaneous Compounding.

*Compounding*, or the combination of remedies, more commonly called the "mixing of medicines," is that division of dispensing which involves, besides mechanical skill, also the application of pharmaceutical knowledge.

The compounding of official preparations has been described under the different classes of these already treated; unofficial preparations belonging to these classes are made by the same processes.

Many mixtures are compounded as needed—*extemporaneously*—and of these some are not even stable, or lack other characteristics, which render necessary especial methods for their preparation.

*Mixture*, in a pharmaceutical sense, is a term applied to any compound of different substances mixed or brought together mechanically. These may be either liquid or solid, and in the former is frequently a clear solution.

The official term, *mistura* (mixture), is also designed to indicate the class of preparations in the U. S. Pharmacopœia in order to distinguish them from more definite compounds or solutions.

The employment of the term "mixture" here means compounds, or preparations, not official, or directed to be prepared extemporaneously. The greatest number of these are prescribed by physicians, and are therefore treated here in connection with the compounding of prescriptions.

*Care* should be observed that all mixtures, especially solutions, be made to appear as clear and inviting as possible.

Solutions of salts, or mixtures of liquids, should always be strained through a piece of unbleached muslin before they are dispensed, whenever the matter rejected is *inert*. As the appearance of a mixture frequently depends upon the method employed in its preparation, the principal points to be observed will be here presented.

In compounding liquid *mixtures*, the most active constituent or base is diluted with the vehicle, or a portion of it, if this is in excess.

If it contain a *solid*, mixture should be effected either by first reducing the solid to a powder in a mortar and triturating with the liquid, or, if soluble, when necessary, by the application of heat to it, contained in a test-tube or capsule. The substance next in order of

activity should then be added, but in such a manner as to avoid decomposition or change, if indicated by its character.

In compounding *solids*, the same general rule should be observed, except that the base must invariably be reduced first to a very fine powder. It should then be incorporated with a portion of the *excipient, diluent or vehicle*, according as it is to be a pill, powder or ointment, until a perfectly homogeneous mixture is obtained. It is then easily mixed with the remainder of the forming body, the Vehicle, to which have been added other active constituents, if present, in case these should be incompatible.

The following mixtures of Solids are unofficial:

FOR INTERNAL USE.

*Cachets*.—Wafers—Consisting of two concentric halves made of starch enclosing the drug fastened together by moisture. Each cachet contains one dose and is to be immersed in water immediately before being swallowed.

*Capsules*.—Made of Gelatin consisting of two parts to be filled with solid or liquid (oil) and closed with a tight-fitting cap.

*Lamelle*.—Thin, square disks of glyco-gelatin in which medicinal agents are in solution.

*Pastilla*.—Pastills—Lozenges made of glyco-gelatin.

*Tabella*.—Tablets—Triturates, Disks composed of Milk Sugar made into a paste with an alcoholic solution of medicinal substances and moulded so as to weigh about 1 grain.

*Linctus*.—A thick medicated syrup.

*Pasta*.—Paste—Similar to confections.

FOR EXTERNAL USE.

*Antiseptic Bandages*.—A fabric of loose texture—Cheese-cloth—saturated in solutions of antiseptic agents in water or alcohol and glycerin, pressed out and made into rolls of 5 yards and wrapped in paraffined paper and kept in air-tight packages. The strength refers to the percentage strength of the solution used.

*Bougies*.—Pencil-shaped Suppositories for medication of the Urethra or air-passages.

*Insufflations*.—Finely powdered substances for blowing into the air-passages.

The directions given for the preparation of Emulsions, Ointments, Pills, etc., in previous Lectures are typical of these classes, and should be followed in extemporaneous practice. In the following, only examples which are exceptions to the general methods are given

## Incompatibility.

When different substances are brought together in a mixture, be it liquid or solid, with the result of undergoing a more or less complete change, they are said to be *incompatible*.

This does not apply to the chemical compounds, or even to some mixtures where the resulting change produces a new compound or compounds desired for use; as, for example, in the preparation of Liquor Ammonii Acetatis or Mistura Ferri Comp. Aside from this consideration, substances of very decided incompatibility are often directed to be mixed *intentionally* with the object of forming a new compound or compounds, for special reasons.

It will thus be seen that the term incompatibility in the generally accepted pharmaceutical meaning, is not always clear, and not invariably indicative of impracticable, unsafe, or otherwise undesirable combinations. There are indeed few instances in which the cause of incompatibility in a mixture cannot be accounted for by well-known chemical principles, and with these could also be explained, were our knowledge sufficiently complete.

The only really *scientific method* of determining the incompatibility, or the contrary, of the ingredients of a mixture is a correct knowledge of chemical laws, and their practical application in pharmacy.

For the purpose of practical work in pharmacy, and especially in that pertaining to prescriptions, a generalization may be attempted by bringing together the more important substances, often directed to be compounded.

Incompatibility may be distinguished as being either of the following: (1) Chemical, or (2) Pharmaceutical.

*Chemical incompatibility* is of the greatest importance, because the change is usually more decided between chemical compounds than between preparations of vegetable drugs, the latter involving chiefly the solubility of their constituents, their mechanical suspension or other physical treatment.

The most common forms of chemical incompatibility occur under the following conditions:

(1) When the solutions of two salts are mixed, resulting in the formation of a new salt, which, being insoluble, precipitates:

R Plumbi Acetatis, Zinci Sulphatis . . . . . ana 1.0

Aquæ Rosæ . . . . . 50.0

M. et S. Shake well and use as an injection.

Here the prescriber desires to exhibit Lead Sulphate, in its freshly prepared state, and directs it to be formed by double decomposition between the two salts, Lead Acetate and Zinc Sulphate. The Sulphuric Acid radical having greater attraction for the Lead, leaves its own base and combines with the Lead, forming Lead Sulphate, while the weak acid, Acetic, being displaced, combines with the Zinc, forming Zinc Acetate, which remains in solution. The Lead Sulphate being insoluble is precipitated as a dense, white powder, but upon shaking the mixture, it is temporarily suspended, hence the necessity of directing the bottle "to be shaken" when the contents are to be used.

A similar decomposition of two soluble salts may, however, under certain conditions not always be desired, or, in fact, not suspected, as illustrated in the following:

B Quininæ Sulphatis . . . . .	gr. xx
Potassii Acetatis . . . . .	gr. xxx
Acidi Sulphurici diluti . . . . .	m. x
Aquæ . . . . .	f. $\frac{3}{4}$ iss
Syrupi . . . . .	f. $\frac{3}{4}$ iv

M. et S. One dessertspoonful every three (3) hours.

In compounding the above, the Quinine Sulphate is dissolved in a portion of the Water, by the aid of the Acid, and added to the Potassium Acetate, previously dissolved in the remainder of Water, the Syrup being added last.

Upon the two solutions being mixed, the acids exchange their bases, resulting in the formation of Potassium Sulphate and Quinine Acetate, the former remaining in solution, while the quinine salt, being almost insoluble, is suspended in the liquid. It is not precipitated, as is the case in the first example, owing to its bulk and light weight, but remains permanently suspended in the liquid, giving to the mixture a consistence which prevents it from being poured, Quinine sulphate being almost insoluble in water, its solution is effected by converting it into the much more soluble Bisulphate by the addition of Acid, but the latter also combines with the Potassium and hence does not prevent the formation of the almost insoluble salt.

(2) With solutions of salts of weak or volatile acids, by the addition of a strong acid, when decomposition results.

Several official preparations and other mixtures are prepared extemporaneously, by decomposing an alkaline carbonate with an acid, such as acetic, citric or tartaric acids. The Solutions of Ammonium Acetate, Magnesium Citrate and Sodium Tartrate are good illustrations.

The carbonic acid of the respective carbonates is easily displaced by the acids mentioned, and, being volatile, escapes, though a portion of it may be retained in the solution if kept in a closed vessel.

In these the decomposition is *intentional*, and since definite compounds in an eligible form are produced, the solutions can not be regarded as incompatible mixtures. But in the case of many pharmaceutical preparations containing acids, *i. e.*, Vinegars, and especially when viscid, as, for example, the Syrups of

Allium and Squills, which are prepared from the vinegars; or of some Fluid Extracts, such as that of Uva Ursi, the addition of an alkaline carbonate produces effervescence and sometimes explosion. Such mixtures should be prepared by adding the vehicle to the solution of the salt in a mortar, under constant stirring. The thinner the liquid the more quickly will the gas escape, hence the solution should be diluted with as much water as is permissible.

(3) Salts of a feeble or volatile base are decomposed by the addition of a strong alkali.

Examples of this are rare; it may be illustrated in the evolution of ammonia, when a strong alkali is added to ammonia-alum and in the decomposition of Chloral Hydrate by alkalies.

(4) Alkaloids, by the addition of alkalies or alkaline salts, are thrown out of solution or precipitated from solutions of their more soluble salts.

The Alkaloids, with but few exceptions, are nearly insoluble in Water, but their Salts, such as the Acetates, Hydrochlorates and Sulphates are comparatively soluble in Water and other neutral or acid liquids. They are, moreover, very powerful medicinally, and hence administered in very small quantities, so that the alkali Salts, usually prescribed in much greater proportion than the alkaloid Salts, may abstract the acid from the alkaloidal base, with the result of throwing the almost insoluble base out of solution. Or what is more frequently the case, even if the alkaloid be soluble as a base in the neutral liquid, the alkalinity of the mixture is sufficient to precipitate it.

It is a general rule that Alkaloids are precipitated by Alkalies. Illustrations may be mentioned of mixtures containing Strychnine Sulphate and Potassium Bromide, the latter in much the largest proportion, and similar preparations. The Alkaloids and their Salts are also incompatible with those chemical compounds with which they produce characteristic reactions. (See Alkaloids.)

(5) Iron and many of its compounds, upon the addition of Tannic Acid and preparations containing it, Gallic Acid, or other vegetable Acids, produce a discoloration or precipitation.

This is a common form of incompatibility and is illustrated, when intentionally employed, in the preparation of ink; this discoloration of mixtures is also often termed "inky." Many examples might be given, but since nearly all vegetable drugs contain more or less of these acids, their preparations are often discolored, when mixed with iron compounds.

The discoloration may be *prevented* by employing certain iron preparations, or compounds of these with other salts, i. e., ammonium or sodium citrate. Especially is this the case with preparations of drugs not containing tannic or gallic acids, but some other vegetable acid, similar to these in being discolored by iron.

The most familiar illustration of this is the formula for Elixir Gentian with Tincture Chloride of Iron, N. F.

Here the familiar discoloration of the gentisic acid with the tincture of iron chloride is prevented by the use of another compound of iron as above indicated.

## PHARMACEUTICAL INCOMPATIBILITY.

The production of more or less insoluble substances in mixtures or preparations associated or not with chemical change, is termed *pharmaceutical incompatibility*.

Pharmaceutical incompatibility is largely a question of solubility and therefore requires for its understanding a knowledge of the behavior of substances to various solvents; the degree of solubility of the many salts and chemical compounds as well as the reactions these produce with pharmaceutical products and preparations. While these are usually not as marked as are the reactions between chemical compounds they frequently result in the formation of insoluble compounds, which should, whenever possible, be prevented without affecting the therapeutic properties of the mixture.

In *liquid Mixtures*, incompatibility is most frequently due to a change in the vehicle or solvent, by the addition of one solution to another causing separation of inert, or active, constituents.

When the separation is of inert constituents only these should be removed by straining or filtration; when of active constituents their separation may often be prevented or at least greatly lessened by either of the following methods:

By *dilution*; the greater the extent of dilution the less the danger from precipitation.

Preparations of drugs containing oils, resin or oleoresin, made with alcoholic menstrua, precipitate, or cause turbidity, when mixed with aqueous mixtures, or those containing only small proportions of alcohol. But by diluting a tincture, or a spirit of these, with less than its measure of diluted alcohol, it may often be added to watery solutions or mixtures, without producing precipitation if not turbidity.

By *suspension*; the greater the density or viscosity of the liquid, the less the danger of change or precipitation.

With many mixtures, dilution can not be practiced; in such cases recourse is had to suspension, by means of *intervention*, through some inert substance. The best general agent to serve this purpose is *acacia*. Preparations of the class above described, resinous drugs, etc., can be mixed with watery solutions to which some acacia, either in the form of powder or mucilage, has previously been added, by trituration in a mortar; care must be observed, that the percentage of alcohol in the finished mixture be not so great as to precipitate the acacia.

*Solubility* must always be considered in all solutions or liquid mixtures. In simple solutions, the active constituents may be directed in larger quantity than soluble in the liquid.

Solutions are called *supersaturated* when they are saturated solu-

tions at a temperature higher than the ordinary and therefore the excess of solid will be thrown out of solution when the liquid assumes the normal temperature.

In dispensing mixtures directing a greater proportion of solid than soluble in the liquid, as in the case of a salt, Potassium Chlorate, for example, it should be added in the form of powder and the mixture directed to be shaken while being used. It may be a liquid and differ in specific gravity from the vehicle, in which case the excess will either float upon the latter, as with a mixture of Carbolic Acid and Water, or of Chloroform and Water, remain in a stratum at the bottom. In the first instance the addition of a little Glycerin will aid the solution of the Carbolic Acid.

It may be more complicated, and a powerful, or, as in the following case, an exceedingly poisonous remedy may be extracted from the mixture by the separated liquid, because of being easily soluble in the latter:

B	Tincturæ Nucis Vomicæ . . . . .	fʒ ii
	Chloroformi . . . . .	fʒ ii
	Aquæ . . . . .	q. s. fʒ iv
M. et S.		

Upon standing, this mixture separates, the Chloroform sinking to the bottom, carrying a portion of the active principles of the Nux Vomica with it. The last dose may contain a poisonous quantity, and great caution must be observed in compounding prescriptions of this class.

With *Solids*, when different substances are acted upon when mixed, dilution often prevents undesirable changes.

In preparing ointments, pills and suppositories, care should be observed that active medicinal substances, when of such character, are each diluted with the vehicle, or excipient, before they be mixed together. Tannic Acid is often directed to be prepared in ointment, or suppository, with Extract of Belladonna, with which it forms an insoluble compound. But when each active constituent is first incorporated with a portion of the vehicle, Lard or Oil Theobroma, no change takes place when mixed, and a smooth and active preparation is easily produced.

Incompatibility may sometimes be both *chemical* and *pharmaceutical*.

Illustrations of this are frequently found in mixtures containing Quinine, associated with some chemical compound, or acid, and a vehicle; which is decomposed by the latter, as in following:

B	Quininæ Sulphatis . . . . .	4.
	Ammonii Chloridi . . . . .	6.
	Elixir Glycyrrhizæ aromatici . . . . .	150.
M. et S.		

Here a reaction takes place between the two salts, with the effect of throwing the active principle of the Glycyrrhiza, glycyrrhizin, out of solution. The same change occurs when diluted Sulphuric Acid is used, and a clear mixture

can only be obtained by leaving out the liquorice. Quinine can be eligibly exhibited, in liquid, either suspended in a viscid liquid, such as syrup of glycyrrhiza, in alcoholic solution, or, in solution, by the aid of acids; a compromise between these, when in large doses at least, is rarely desirable.

In the following list, the substances, which can not be classed as incompatible under any of the above divisions, are given for reference:

SUBSTANCE.	INCOMPATIBLE WITH
<i>Acacia</i> .....	{ Alcohol, alcoholic and ethereal Tinctures;* Borax; Ferric chloride; Lead salts.
<i>Acids</i> , in general ...	{ Alkalies, Alkaline solutions; Metallic Oxides.
<i>Acid Arsenous</i> .....	{ Ferric Hydrate; Magnesia; Lime water.
<i>Salicylic</i> .....	{ Iron compounds; Potassium iodide;* Lime water.
<i>Tannic</i> .....	{ Alkalies, carbonates and bicarbonates; Lime water; Chlorine water; Albumen; Gelatin.
<i>Bismuth</i> .....	{ Calomel; Sulphur; Tannin
<i>Subnitrate</i> ....	{
<i>Chloral</i> .....	{ Alkalies, carbonates;* Ammonium and Mercury compound; Potassium bromide and Alcohol.
<i>Hydrate</i> .....	{ pounds;
<i>Iodine</i> .....	{ Ammonia;* Alkalies, carbonates; Chloral; Metallic salts; Starch.*
<i>Lead</i> . ....	{ Acacia; Acid Hydrochlor; Acid Sulphuric and sulphates; Ammon. chloride; Carbonates; Lime water; Iodine; Acetate .....
	{ Potassium iodide; Tannin.
<i>Mercury</i> .....	{ Potassium iodide;* Salts, carbonates; Tannin, Borax.
<i>Bichloride</i> ....	{
<i>Mild Chloride</i> .....	{ Acids, acid salts; Alkalies, carbonates; Ammon. chloride; Iodine; Potassium iodide; Ferric chloride, iodide; Sulphur. (Calomel) ...
<i>Potassium</i> .....	{ Acids, mineral; Calomel; Organic substances; Sulphur.
<i>Chlorate</i> .....	{
<i>Iodide</i> .....	{ Acids, acid salts; Alkaloids; Iron; Lead and Mercury salts; Potassium chlorate; Silver nitrate; Chlorine water.
<i>Permanganate</i> . .....	{ Ammonia, salts; Alcohol; Glycerin; Ethereal oils; Organic substances.
<i>Sodium</i> .....	{ Acids, acid salts; Acid Tannic; Alkaloids; Metallic salts.
<i>Bicarbonate</i> ...	{
<i>Bromide</i> .....	{ Acids, mineral; Chlorine water; Mercury compounds.
<i>Silver</i> .....	{ Acids Acetic, Hydrochloric, Hydrocyanic, Sulphuric, Tartaric, and their salts; Alkalies, Carbonates; Iodine; Nitrate .....
	{ Potass. iodide, bromide; Sulphur.

Those marked with an\* are sometimes directed to be compounded for the purpose of effecting some especial change or producing new compounds.





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